Bratton's Book

THE MOTORCYCLISTS' STANDARD REFERENCE BOOKLET

Jeffrey A. Bratton

COVER

Bratton's Book

THE MOTORCYCLISTS' STANDARD REFERENCE BOOKLET

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'86?

ADDRESS

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Compilation & Development

by

Jeffrey A. Bratton

we welcome any
suggestions

&

appreciate
any errors found

Printed in U.S.A.

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MAKE LESS THAN 1/2 PAGE

HAVING RIDDEN OVER 100,000 MILES ON 9 MOTORCYCLES

ABOUT THE AUTHOR.....

Since 1964 Ihave been fascinated with motorcycles. Little did I suspect that my first bike, one of the earliest oil-injected Yamaha YDS3 250 brought into the country, would transform my future. Remove some bolts, pull the fuel lines and wiring harness, drop the chain, disconnect the pipes, and walk down the street with 25-hp - with 5-speed gearbox - tucked into your arms. What a far cry from my first engine rebuild, at age ten, a 3-hp Briggs & Stratton.

Looking back, I was much more fascinated with the Yamaha engine than the '46 Desoto 6-cylinder engine I overhauld for my fathre when I was about 13. Much has happened since those early days.

I started designing my dragbike before the 1967 Yamaha YR1 350 twin came into the country. Fourteen months later I had run my first from-the-ground-up project. Designed and built the expansion chambers from the ground up. My first attempt at serious 2-stroke porting, head work, and carb modificatons.

When Yamaha was soritng their way through those early 350 twin road racers, the TR1's, I had a 190-lb dragbike, with modified stock parts, running 11.80 @ 114.01-mph on gas. That accomplishment had me shifting my architect's career to a motorcycle shop that handled Hodakas, Suzukis, and Kawasakis. Working in a a Yamaha shop came later. Experience was what I wanted and experience is what I set out to get.

With big dreams in mind, I hung up my own shingle early in 1971. Open for any work on two-strokes. Within a year or so, rebuilding roller crankshafts and modifying engines for racing took up all my time. By 1974 I had more work than I could handle.

The burnout came in EARL '75. In 4 years I had been to over 150 motorcycle races of all types, helping those with engines that I had modified. I had rebuilt my way through over 650 roller crankshafts. And I had modified, from trials to Bonneville purposes, over 240 2-stroke engines. I had accumulated several drawers of notes. With the exception of time off for racing events, I had put in as many as 90 straight days of work without any time off. And I am not talking about your average 8-hour days. 15 to 18-hour days were the norm.

Wanting to retain the quality of work I preferred, and wishing to sleep as well as I did, hiring help seemed not an answer. Had to eliminate the engine modifying business or the crankshaft work. I elected to keeep rebuilding the orller crankshafts for several reasons. It was cleaner work, I could call my hours with a bit more satisfaction, and I could remain very close to the latest technology as a good share of the crank work came from the road racing crowd.

& I COULD CUT BACK ON TRIPS TO THE TRACK.

During these early years, I had accumulated a great deal of information, on 2-stoke engines. I worked with many unique individuals. And I was inspired by the writings of those people with the right touch, Bryon Farnsworth, Gordon Jennings, and Kevin Cameron, to name a few.

Several years later, and still involved with the roller crankshaft work, I began thinking that some of the inofrmation I had collected, learned, and might develop further, could be of some value to the average engine enthusiast. And time will certainly be the judge of that.

This manual is the result of about 4 years of serious effort. I believe it will help fill a gap for all you engine enthusiasts, as most of it did for myself. JAB

I'd DELETE THIS PAGE

ROUGH DRAFT

MAR '85

THE BOOK'S PURPOSE.....

...to give assistance to those individuals that ~~lack the proper experience but~~ have the enthusiasm to try their hand on any phase of engine work.

...to provide, as a reference source, much information that is hard to come by.

...to provide, as a reference source, much information that is considered a standard collection of often used conversion factors, equivalents, and formulas used for many aspects of engine owrk.

...to feed and nurture any spark of interest for the enthusiast in general, and to help develop those interests.

...to help extend the developed talents of those enthusiasts with many years of engine experience.

...to help provide any further incentive to do your own thing, develop your own ideas, and promote the d4sire for more personal engine investigation.

...to help,in any way possible, the elimination of costly errors, as discouragement alone will falsely handicap many an enthusiast.

...to help speed one's progress in experience and knowledge.

...to make success a little easier to accomplish to the same degree that it will make failure a little harder to experience.

...to provide, with the use of worksheets and engine computer printouts, time-saving devises that are often the killer of time.

PURPOSE

ACKNOWLEDGEMENTS

RIGHT

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DEDICATION

RIGHT

TABLE OF CONTENTS

FUEL-OIL RATIOS 4

OUNCE-CC MEASUREMENTS 5
FRACTIONAL-DECIMAL-METRIC EQUIVALENTS OF ONE INCH 6

TWIST DRILL NUMBER & LETTER SIZE INCH-DECIMAL EQUIVALENTS 12
TAP & DRILL SIZES 13

INCH-MILLIMETER EQUIVALENTS 18

CUBIC INCH-CUBIC CENTIMETER EQUIVALENTS 20

FLUID OUNCE-CUBIC CENTIMETER EQUIVALENTS 22

METRIC-ENGLISH CONVERSION TABLES 24

BRITISH-ENGLISH-METRIC CONVERSION TABLES 29
INTERRELATION OF UNITS OF MEASUREMENTS 30

LENGTH-LIQUID-WEIGHT-VELOCITY EQUIVALENTS 34

COMMON LENGTH FORMULAS 36
COMMON AREA FORMULAS 36
COMMON VOLUME FORMULAS 37

GEAR RATIO FORMULAS 38

SPEED-RPM-FINAL GEAR RATIO-WHEEL SIZE FORMULAS 39
MILES PER HOUR FORMULAS 40
PISTON SPEED FORMULAS 40
COMPARISON OF WIRE & SHEET METAL GAGES 41

INCHES IN DECIMALS OF A FOOT 43
ANGLE EQUIVALENTS 44
MINUTES-TO-DEGREE DECIMALS & SECONDS-TO-MINUTE DECIMALS 44
MELTING POINT & DENSITIES OF VARIOUS ELEMENTS, ALLOYS, & LIQUIDS 45
COLOR SCALE OF TEMPERATURES FOR MILD STEELS 46

LEFT

6/28/84

THE MOTORCYCLISTS' STANDARD REFERENCE BOOK

A. Title Cover
B. Copyright Page (I)...right half
(II) Blank page .....left half
(III) Purpose & Acknowlegements page.....right half
(IV) Blank page.....left half
(V) Dedication page.....right half
(VI) Table of Contents page.....left half
(VII) Table of Contents page.....right half
C. Book Sections
1. THE TI-30II HAND CALCULATOR.....left half
2. FUEL-OIL RATIOS & OUNCE-CC MEASUREMENTS.....right half
3. FLUID OUNCE-CUBIC CENTIMETER EQUIVALENTS.....Left half
4. CUBIC INCH-CUBIC CENTIMETER EQUIVALENTS.....right half
5. INCH-MILLIMETER EQUIVALENTS.....left half
6. DECIMAL EQUIVALENTS OF MILLIMETERS.....right half
7. ...left half
8. FRACTIONAL-DECIMAL-METRIC EQUIVALENTS OF ONE INCH/.right half
9. " ..left half
10. " ..right half
11. " ..left half
12. " ..right half
13. " ..left half
14. " ..right half
15. INCHES IN DECIMALS OF A FOOT & TWIST DRILL NUMBER & LETTER SIZE INCH-DECIMAL EQUIVALENTS.....left half
16. TAP AND DRILL SIZES TO ONE-INCH.....right half
17. " .....left half
18. " .....right half
19. INTERRELATION OF UNITS OF MEASUREMENTS.....left half
20. " .....right half
21. LENGTH-LIQUID-WEIGHT-VELOCITY EQUIVALENTS.....left half
22. METRIC-ENGLISH CONVERSION TABLES.....right half
23. " .....left half
24. BRITISH-ENGLISH-METRIC CONVERSION TABLES.....right half
25. COMPARISON OF WIRE & SHEET METAL GAGES.....left half
26. " .....right half
27. MELTING POINT & DENSITIES OF VARIOUS ELEMENTS, ALLOYS, & LIQUIDS & COLOR SCALE OF TEMPERATURES FOR MILD STEELS.....left half
28. MINUTES-TO-DEGREE DECIMALS & SECONDS-TO-MINUTE DECIMALS and ANGLE EQUIVALENTS.....right half
29. MILES PER GALLON FORMULAS and MILES PER HOUR FORMULAS.....left half
30. GEAR RATIO FORMULAS.....right half
31. SPEED-RPM-FINAL GEAR/RATIO-WHEEL SIZE FORMULAS.....left half
32. " .....right half

33. GEAR RATIOS - DISCUSSION.....left half
34. GEAR RATIO ~~CHART~~.TABLE.WORKSHEET.....right half

35. WORKSHEET (MOTO-CROSSER) FILLED OUT.....left half
36. WORKSHEET (ROAD RACER) FILLED OUT.....right half

37. WORKSHEET PRINTOUT (MOTO-CROSSER).....left half
38. WORKSHEET PRINTOUT (ROAD RACER).....right half

39. GEAR/SPROCKET RATIO CHART.....left half
40. " .....right half

41. " .....left half
42. " ////// .....right half

43. " .....left half
44. " .....right half

45. " .....left half
46. " .....right half

47. " .....left half
48. " .....right half

49. " .....left half
50. " .....right half

51. 2-STROKES: GENERAL NOTES.....left half
& a. Reference the TI-30II calculator
52. b. Wristpin offset
c. Gas, Oil, Timing, Compression Ratios & affects
d. Time Angle-Area of porting
e. Transfer Roof Angles & Directions
f. Factory generally does their Homework
g. Etc. .....right half

&
53. " .....left half
54. SOLVING FOR A ROD LENGTH discussion or .....right half

55. ROD LENGTH SOLVING.....left half
a. using info in this book
b. measuring with venier calipers
c. using a degree wheel & dial indicator////
d. formulas
e. diagram for 0-300cc cylinder
& f. diagram for 300-larger cylinder
56 g. etc. .....right half

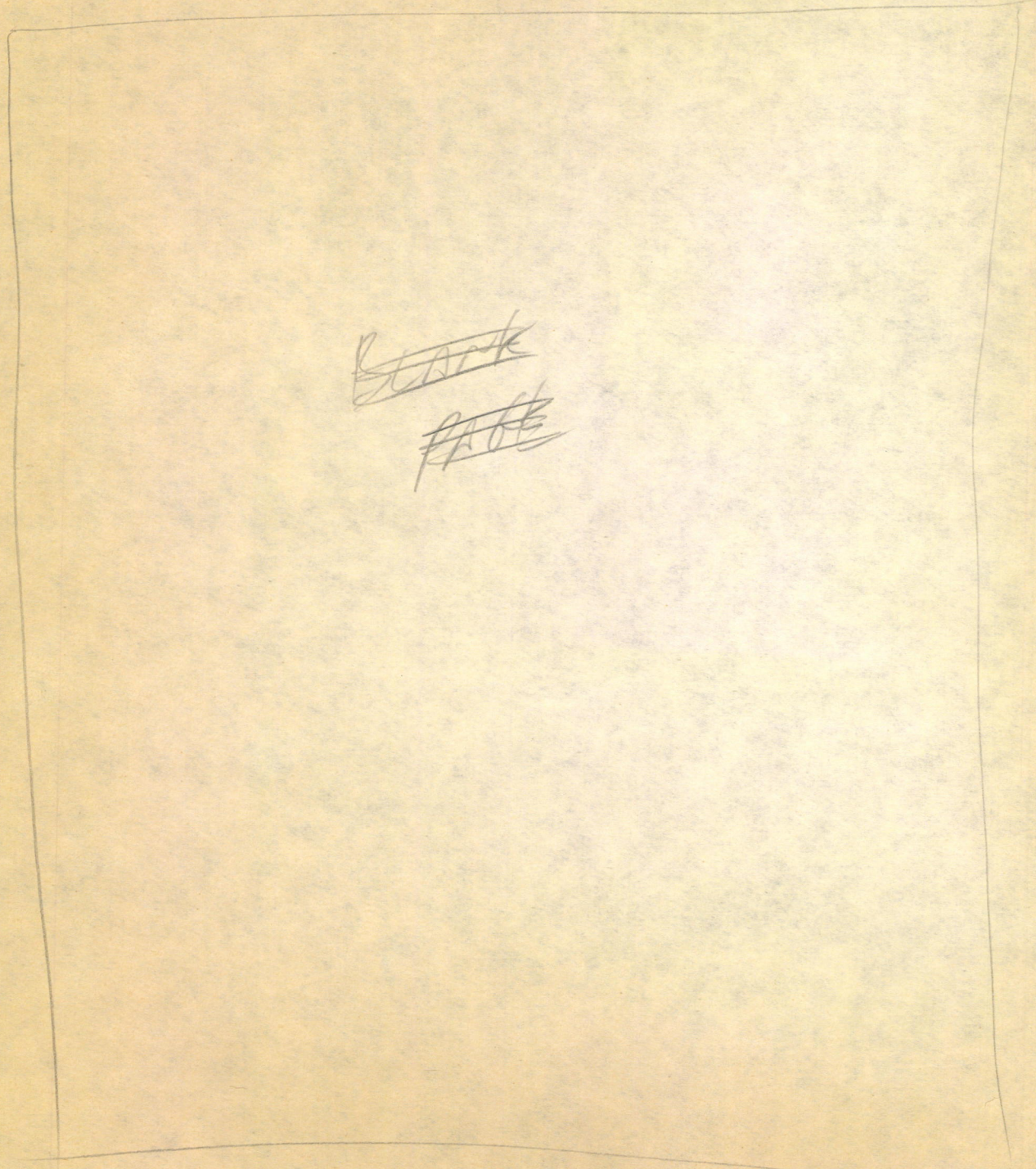
57. ROD LENGTH SOLVING
a. blank work sheet
b. filled out worksheet for TZ
c. filled out worksheet for NINJA??.....left half

TABLE OF CONTENTS (CONTINUED)

RIGHT

1

THE TI-30II CALCULATOR



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Rod Length Discussion

Read First:

Tony Murphy's Article

"X-Ray of the XR"

In my files

PAGE ~~X~~ 51 FOR PORTING SECTION ~~PAGE~~ RIGHT 7 5/20/24

SOLVING FOR A ROD LENGTH ~~[illegible]~~
- FROM CENTERS OF SMALL-END ID TO ~~[illegible]~~ BIG-END ID -

RIGHT

MENTION FM SE ID TO BE ID

MOST ENGINE WORK (E.G. 2-STROKE PORTING & 4-STROKE CAM & VALVE COMPUTATIONS) WILL REQUIRE THE RL FOR THE ENGINE BEING WORKED. THE FOLLOWING FORMULAS WILL PROVIDE THE RL WITHOUT DISASSEMBLING THE ENTIRE ENGINE ~~& POWER~~ &/OR REMOVING THE ROD(S) FROM THE CRANKSHAFT.

MENTION 3 METHODS: ~~[illegible]~~ MEAS. DIRECTLY, LOOK AT CHART, & USING DEG. WHEEL

EVEN THO SOLVING FOR THE RL IS IDENTICAL IN ALL CASES, THE ~~P~~PROCEDURE IS BASICALLY ~~BROKEN~~ DIVIDED INTO TWO CYLINDER DISPLACEMENT CLASSES (IN ALL CASES, WORK WITH ONE CYLINDER PER ENGINE).

- DISCUSS ROD ANGULARITY

To ACCOUNT FOR THE FACT THAT MOST ~~OF US~~ INDIVIDUALS WORK WITH A 1-INCH TRAVEL DIAL INDICATOR, ---- 2 DEG-WHEEL SETTINGS ---> --- 0-300cc & 300cc CYLS & LARGER --- --- OF COURSE THERE IS MUCH OVERLAP & BOTH DEG SETTINGS CAN BE TRIED AS THE STROKE & ROD L. COMBINATION MAY PERMIT IT ----

NEED ROD ANGULARITY FORMULA SOMEWHERE

GO IN TO USING DEG WHEEL, & SETTING UP THIS PAGE & FINGER PRESSURE ON INDICATOR MIGHT BE OF USE ETC

STR

(CONTINUED FROM PRECEDING PAGE)

LEFT

ROD LENGTH SOLVING

CONTINUED FM DISCUSSION (EXPANDED) ON PRECEDING PAGE

1. USING THE INFO IN THIS BOOKLET

2. MEASURING
   - NOTES/DIAGRAM ON ROD & VENIER CALIPERS & ½'ING BOTH ID's

RIGHT

ROD LENGTH SOLVING

3. DEGREE WHEEL.

WRITE BLANK TI-30II FORMULA

DIAGRAMS FOR 0.300cc CYL

(MAKE FILLED OUT FORMULA)

DIAGRAMS FOR 300-UP CYL.

(MAKE FILLED OUT FORMULA)

50

54

(CONTINUED ON FOLLOWING PAGE)

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ROD LENGTH SOLVING

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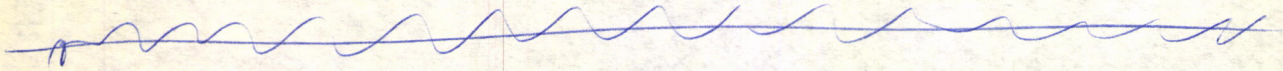

FILLED OUT WORK SHEET - TZ250

FILLED OUT WORK SHEET -

GET LARGE KAWASAKI FROM MIKES CYCLES

PAGE ~~4~~ 53 OF PORTING SECTION

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5/27/84

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ROD LENGTH SOLVING

~~TI~~-30II WORKING EXAMPLE

USE '81 YAMAHA TZ250H

~~'84~~

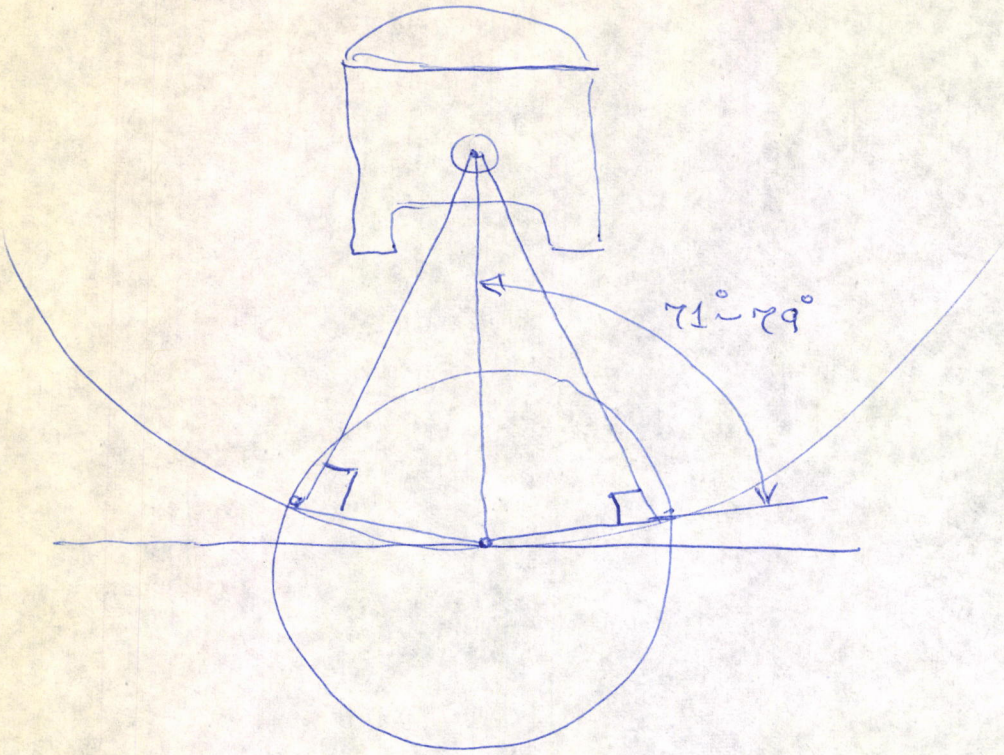
~~ROTAX 280 "/286"~~

KAWASAKI

LARGE BORE

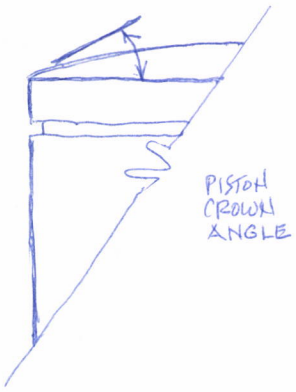
SOMEWHERE IN BOOK:

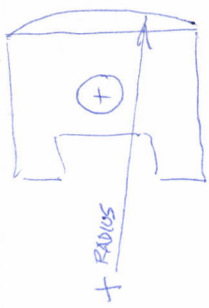
MAX PISTON VELOCITY OCCURENCE °

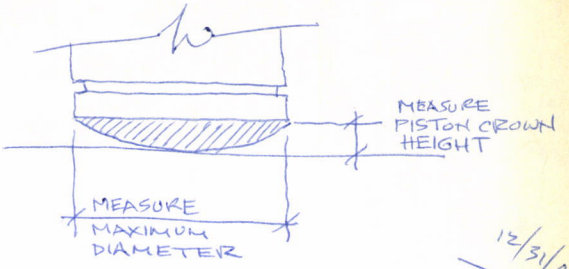


- WITH SEVERAL DIAGRAMS, SHOW PISTON "SETTING" CLOSE TO TDC & BENDING "MOMENT" AFFECT ON ROD

PISTON DOME, WITH CONSTANT RADIUS







12/31/90

ISRATION

FORMULAS/KEY SEQUENCE USING TI-30 CALCULATOR

ALL INPUT IN MM

FIND CROWN RADIUS:

PISTON CROWN HEIGHT | STO | x^2 | × | 4 | + | MAXIMUM PISTON CROWN DIAMETER | x^2 | = | ÷ | (| 8 | × | RCL |) | = | ANSWER MM

ROUNDED OFF MM

FIND CROWN ANGLE:

MAXIMUM PISTON CROWN DIAMETER | x^2 | = | ÷ | 2 | ÷ | MAXIMUM PISTON CROWN DIAMETER | ÷ | PISTON CROWN RADIUS | = | INV | cos | +/- | + | 90 | = | ANSWER °

ROUNDED OFF °

FIND CROWN VOLUME:

PISTON CROWN HEIGHT | STO | × | π | × | (| MAXIMUM PISTON CROWN DIAMETER | x^2 | ÷ | 8 | + | RCL | x^2 | ÷ | 6 |) | ÷ | 1000 | = | ANSWER cc

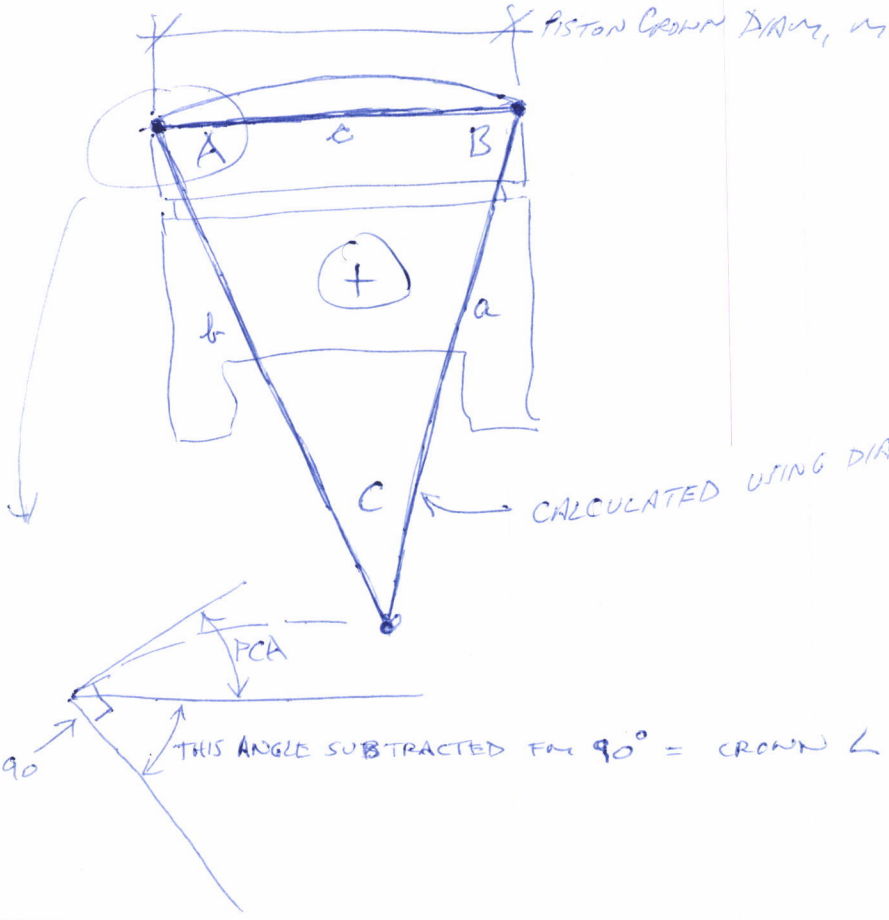
ROUNDED OFF cc

FIND PISTON CROWN ANGLE

(~~FOR~~ CONSTANT ~~RADIUS~~ CROWN RADIUS ONLY PISTON)

12/15/90

ALL DIMS IN MM



$$\angle A = \frac{f^2 + c^2 - a^2}{2bc} = \frac{c^2}{2bc} = \frac{PCD^2}{2(PCR)(PCD)}$$

INV | COS | +/- | + | 90° | = | ANSW

PCA = PCD ~~55.55~~ 55.60 | x^2 | = | ÷ | 2 | ÷ | PCD ~~55.55~~ 55.60 | ÷ | PCR ~~172.56~~ 173 | = | ....

INV | COS | +/- | + | 90 | = | ANSWER ~~9.263~~ 9.247 ° = ROUNDED 9.25°

99
TZ-250W

12/15/90

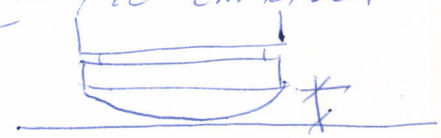
FIND PISTON CROWN VOLUMES

(FOR CONTANT PISTON CROWN RADIUS DOME ONLY)

— INPUT IN MM

— MEAS PISTON CROWN RING LAND DIAM @ 90° & 80° CAREFULLY

— MEAS PISTON CROWN HEIGHT CAREFULLY



PCH

2.25	STO	×	π	×	(

PCD

~~55.55~~ 55.60	x^2	÷	8	+	.....

RCL	x^2	÷	6	)	÷	1000	=

ANSWER: ~~2.732~~ 2.7[illegible]37 cc

ROUNDED: 2.74 cc

'89 TZ250W

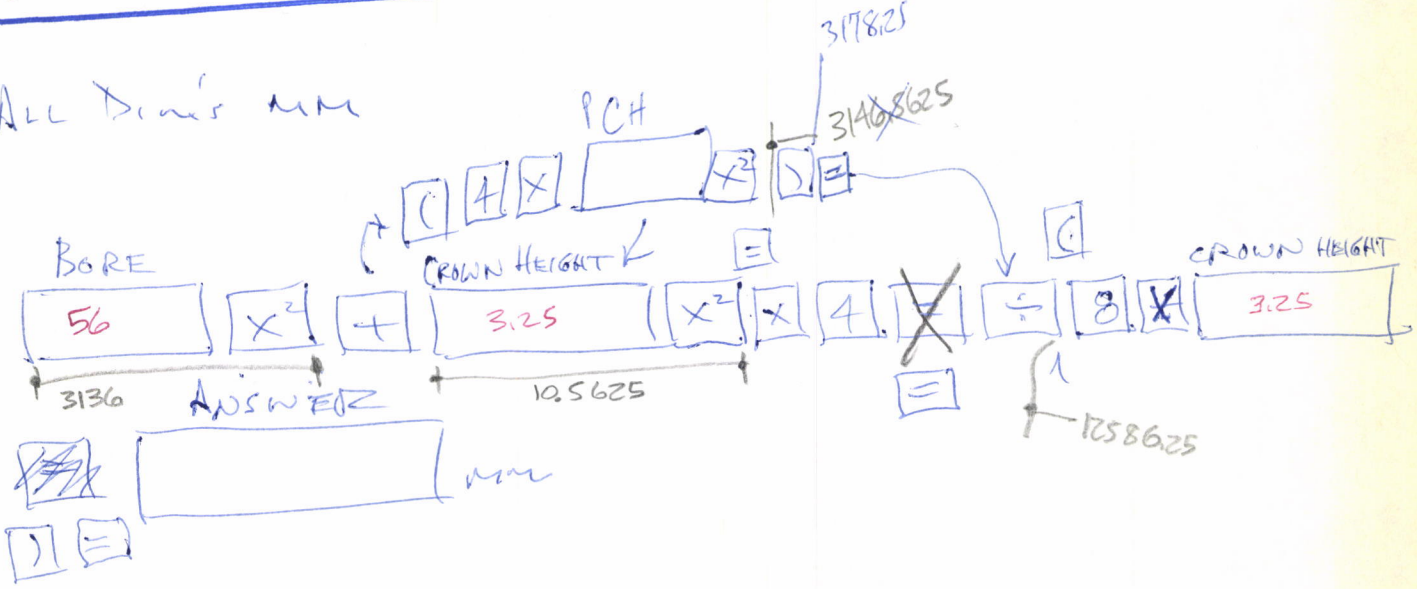
12/15/90

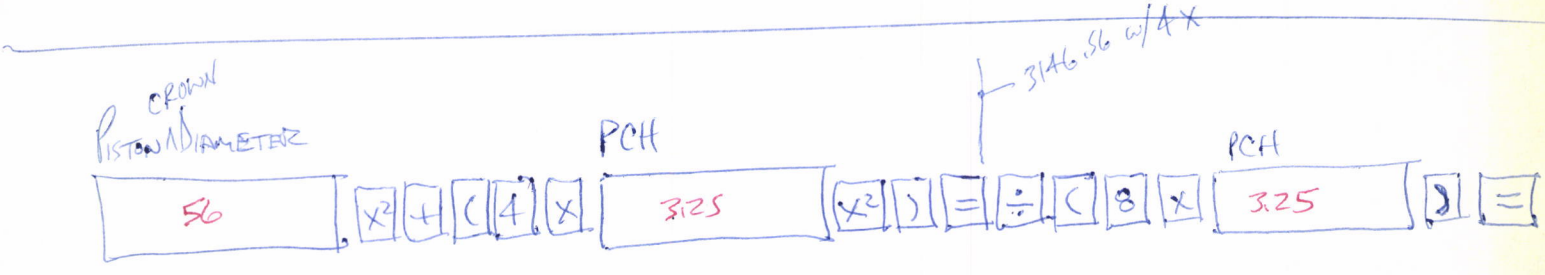
MEASURE CAREFULLY: PISTON CROWN HEIGHT & PISTON CROWN DIAMETER AVE. MEAS @ 90° & 90°

RADIUS OF CONSTANT RADIUS PISTON DOME

(2-STROKE ENGINES, GENERALLY)

— ALL DIMS MM





PCH
3.25
STO
x²
x 4 +
PCD
56
x² = ÷ (8 x RCL) =
ANSWER
122.24038 MM

PCH HEIGHT
[redacted]
2.25
USE

MAXIMUM
PCD DIAMETER
[redacted]
55.55
USE
55.60

STO x² x 4 + x² = ÷ (8 x RCL) =

ANSWER
172.95847
FINAL ROUNDED = 172.867 MM
173.00 MM

'89 TZ 250 W

DC3-CODE:ENABLE DISABLE

CR-CODE :CR-ONLY CR&LF

LF-CODE :LF-ONLY LF&CR

RIGHTEND:WRAP OVR-PRNT

==END==

FUNCTION:PANEL MENU1 MENU2 HARDWARE LIST DEFAULT SELF-TST HEX-DUMP
V-ALNMNT TOF-ADJ SAVE/END

FOR WALL UART SECTIONS

WP 5.1

10/30/95

PRINTER CONFIG.

PRINTOUT COMPARED TO WHAT'S TAPED ON WALL, IS SLIGHTLY DIFFERENT (CHK UNDERLINES) BUT THIS LOOKS OK

Filename: SECTN_K.BSR Date: 12/26/91 Copyright 1991, Jeff Bratton For: Steve Schultz's eyes only

K. FRUSTUM OF CONE, LENGTH/DIAMETERS/VOLUME/INCLUDED ANGLE Useful for 2-stroke exhaust system studies. For exhaust straight section volume, see Section T, Volume of Cylinder formula. Note: variable **L** is gas flow centerline, & is **not** parallel to cone wall. See Section L for cone template.

Variables: **D** = large Diameter **L** = centerline Length between diameters **V** = Volume of frustom of cone
d = small diameter **IA** = Included Angle of cone, degrees

Input:)	Calculator Key-Press Sequence:		Example Problems (using same cone): If:	Then:
inch) **V** =	[D] [x] [d] [+] [D] [x^2] [+] [d] [x^2] [=] [x] [L] [x] [.2618] [=]	[answer]cu in.	D=4,d=1.25,L=10	/ V=59.069cu in.
mm) **V** =	[D] [x] [d] [+] [D] [x^2] [+] [d] [x^2] [=] [x] [L] [x] [.2618] [x] [.001] [=]	[answer]cc	D=101.6,d=31.75,L=254	/ V=967.96cc
either) **IA** =	[D] [-] [d] [=] [÷] [(] [2] [x] [L] [)] [=] [INV] [TAN] [x] [2] [=]	[answer]deg	D=4,d=1.25,L=10	/ IA=15.658deg
either) **D** =	[IA] [x] [.5] [=] [TAN] [x] [2] [x] [L] [+] [d] [=]	[answer]in./mm	IA=15.658,L=10,d=1.25	/ D=4in.
either) **d** =	[IA] [x] [.5] [=] [TAN] [x] [2] [x] [L] [=] [±] [+] [D] [=]	[answer]in./mm	IA=15.658,L=254,D=101.6	/ d=31.75mm
either) **L** =	[D] [-] [d] [=] [x] [.5] [=] [÷] [(] [IA] [x] [.5] [)] [TAN] [=]	[answer]in./mm	D=4,d=1.25,IA=15.658	/ L=10in.

L. FRUSTUM OF CONE, TEMPLATE LAYOUT ON FLAT SURFACE Input Type, same as used in Section K. IA calculated from Section K. Lay out as follows:

1) Scribe 2 converging lines, with included Template Angle of: **TA** = [IA] [x] [π] [=] ..... [answer]deg IA=15.658 / **TA**=49.19deg
2) Out from converging point, mark small diameter of cone Arc line, at Radius: **dAR** = [59.2958] [x] [d] [x] [π] [=] [÷] [TA] [=] [answer]in./mm d=1.25,TA=49.19 / **dAR**=4.574in.
3) Out from converging point, mark large Diameter of cone Arc line, at Radius: **DAR** = [59.2958] [x] [D] [x] [π] [=] [÷] [TA] [=] [answer]in./mm D=4,TA=49.19 / **DAR**=14.637in.
4) With compass on converging point, & adjusting as necessary, scribe thru arc marks **dAR** & **DAR** & connect both diverging lines with 2 arcs.
5) Cut out template & roll; trim, fit, & weld.

- SET PERF
- TURN ON PRINTER, SELECT MENU 2.0
  - [ONLINE] PRESS
  - [MODE] PRESS 3 TIMES (LT TO BTM MODE)
  - [LF] PRESS (SELECT)
  - [MODE] PRESS (NO LIGHTS)
  - [ONLINE] PRESS (LIGHT ON)
- PRINTER RDY TO USE

*** SETUP MODE ***

ACTION	BUTTON
Return to main Function Menu	<ONLINE>
Select Option and go to next Item	< F F >
Select Option and return to previous Item	< L F >
Move between Options	< MODE >

FUNCTION:PANEL MENU1 MENU2 HARDWARE LIST DEFAULT SELF-TST HEX-DUMP
V-ALNMNT TOF-ADJ SAVE/END

QUALITY :LETTER DRAFT HI-DRAFT

FONT :COUR 10 PRSTG12 COMPRSD FNTCARD0 FNTCARD1 FNTCARD2 FNTCARD3
FNTCARD4 FNTCARD5 FNTCARD6 FNTCARD7 DOWNLD0 DOWNLD1

CHR-WIDE:NORMAL 2-TIMES 4-TIMES

CHR-HIGH:NORMAL 2-TIMES 4-TIMES

CHAR-SPC:2.5CPI 3 CPI 5 CPI 6 CPI 10CPI 12CPI 15CPI
17CPI 18CPI 20CPI PROP-SP

LINE-SPC:1LPI 2LPI 3LPI 4LPI 5LPI 6LPI 7LPI
8LPI

EMULATE :DPL24I IBM-GPH IBM-PRO FX-80 DPL24D DIABLO

ATTRIBT :NONE ITALICS CONDNSD SHADOW BOLD

PAGE-LG :11INCH 11.6INCH 12INCH 14INCH 18INCH 3INCH 3.5INCH
4INCH 5INCH 5.5INCH 6INCH 7INCH 8INCH 8.5INCH

LEFT-END:1COLM 6COLM 11COLM 16COLM 21COLM 26COLM 31COLM
36COLM 41COLM

TOP-MRGN:1LINE 2LINE 3LINE 4LINE 5LINE 6LINE 7LINE
8LINE 9LINE 10LINE

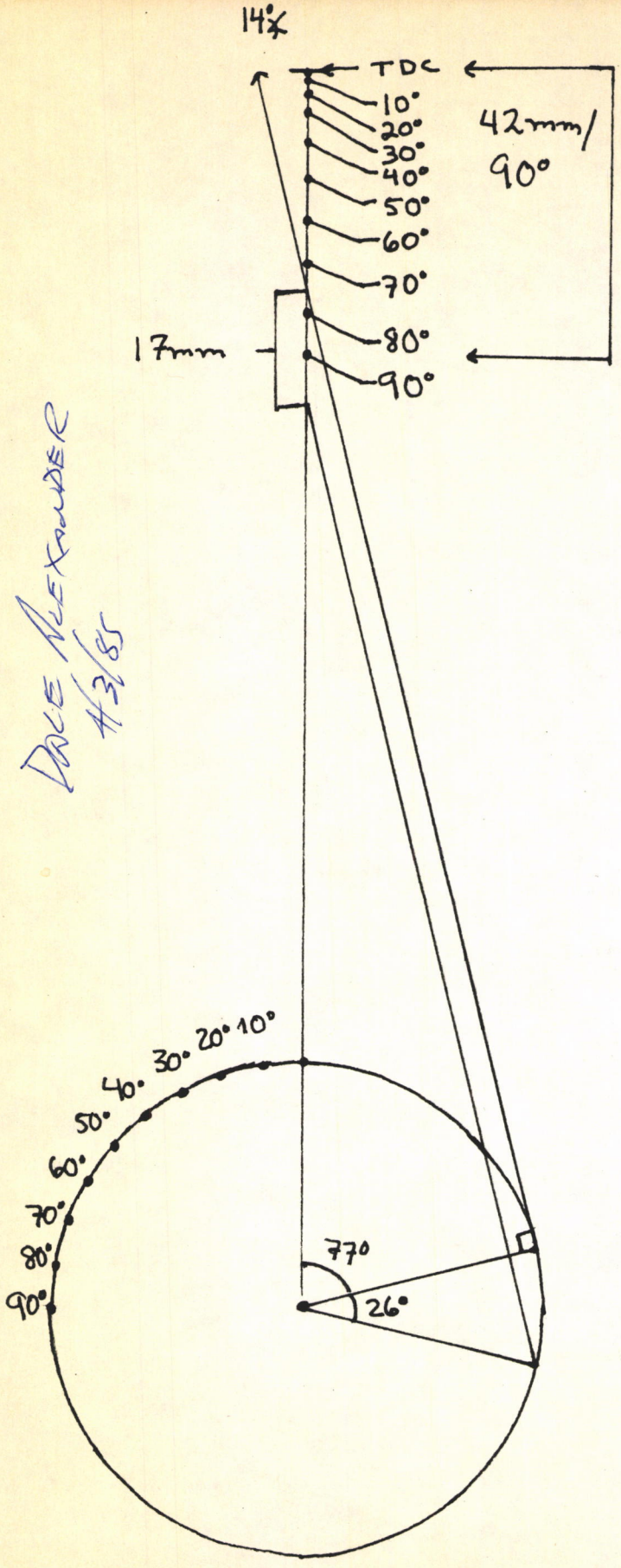
LANGUAGE:USA UK GERMAN FRENCH ITALIAN SPANISH SWEDISH
FINNISH DANISH NORWEGN

CHAR-SET:SET1 SET2

PERFRATN:SKIP NO-SKIP

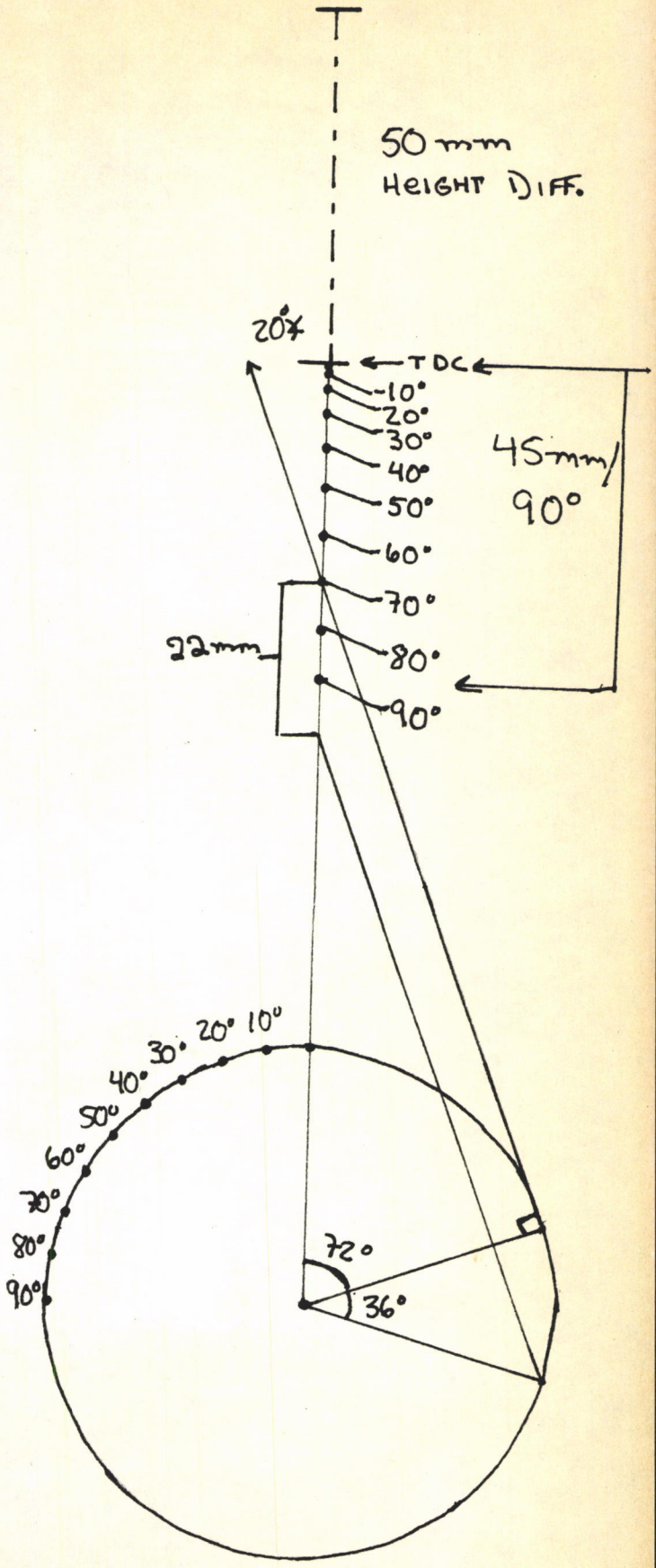
WIDTH :8-INCH 13.6INCH

ZEROFONT:NO-SLASH WITHSLSH



DRUE ALEXANDER
#3/85

74 mm
STROKE
150mm ROD
2.03:1 RATIO



74 mm
STROKE
100mm ROD
1.35:1 RATIO

57

YEAR	MFR	MODEL	BORE	STROKE	SINGLE CYL. DOC ROD LENGTH ✓	BORE/STROKE RATIO	ROD LENGTH/STROKE RATIO

ROD ~~LENGTH~~ ANGULARITY

LEFT

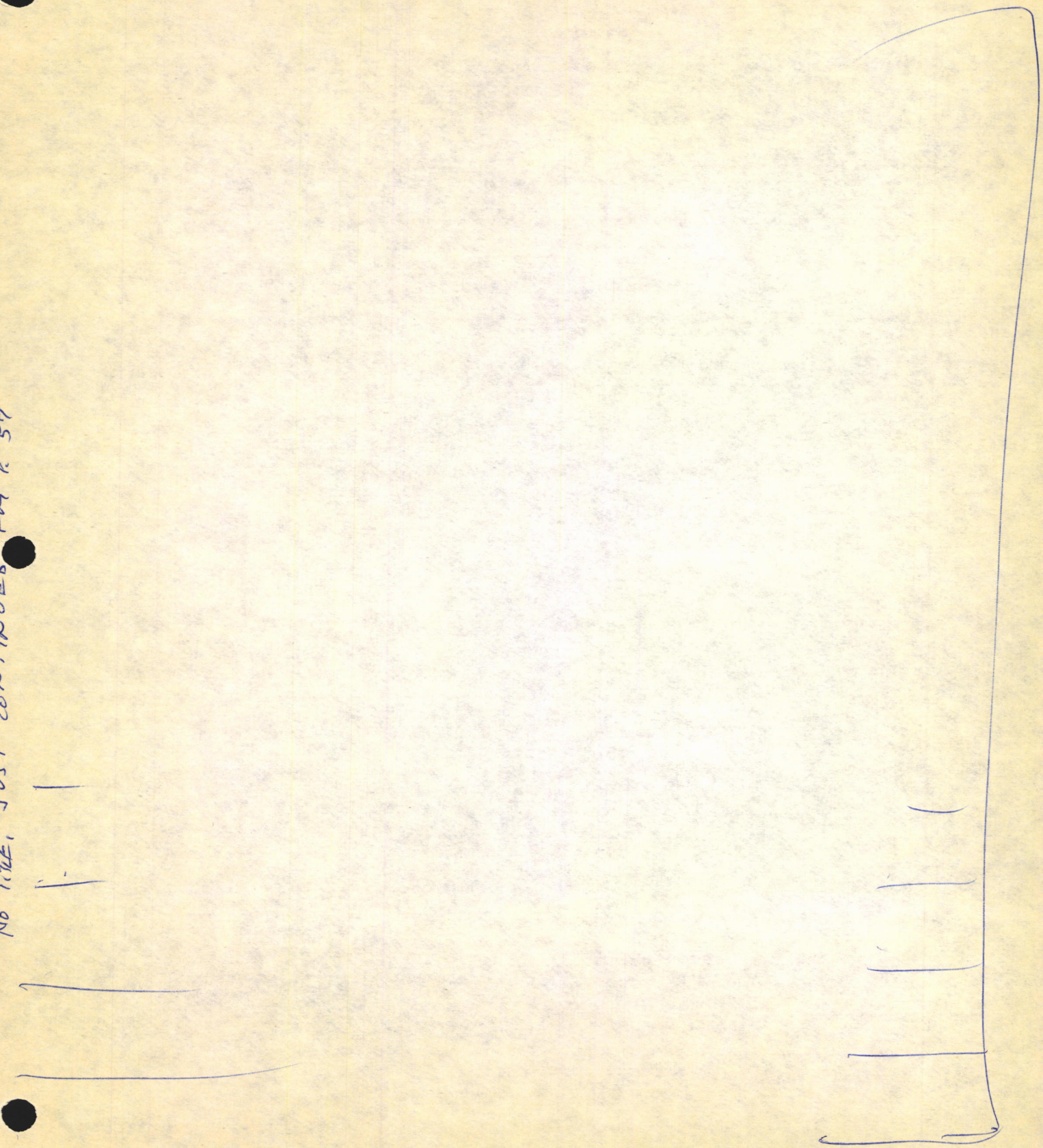
GIVE MORE ROOM

BORE, STROKE, ROD LENGTH & ANGULARITY TABLE

~~BORE, STROKE, ROD LENGTH & ANGULARITY TABLE~~

RIGHT

NO TITLE, JUST CONTINUED FM P. 57



95

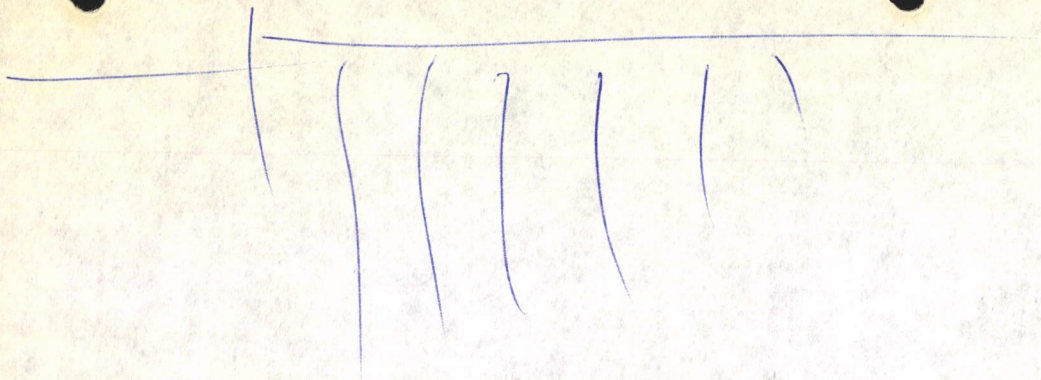
MODEL	SINGLE CYL. — CC - DISPLACEMENT CATAGORY & ROD ANGULARITY				
	100	200	300	400	500

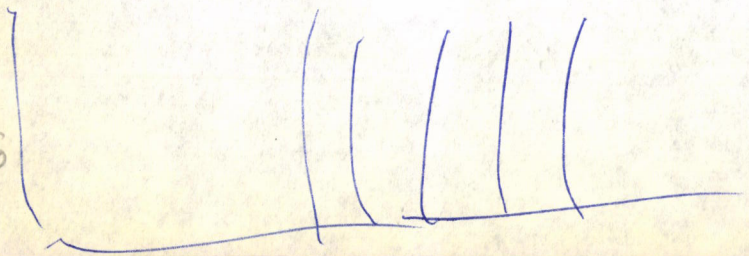
LIST
4-STROKE
V-8's FM
MY
TABLE

LEFT

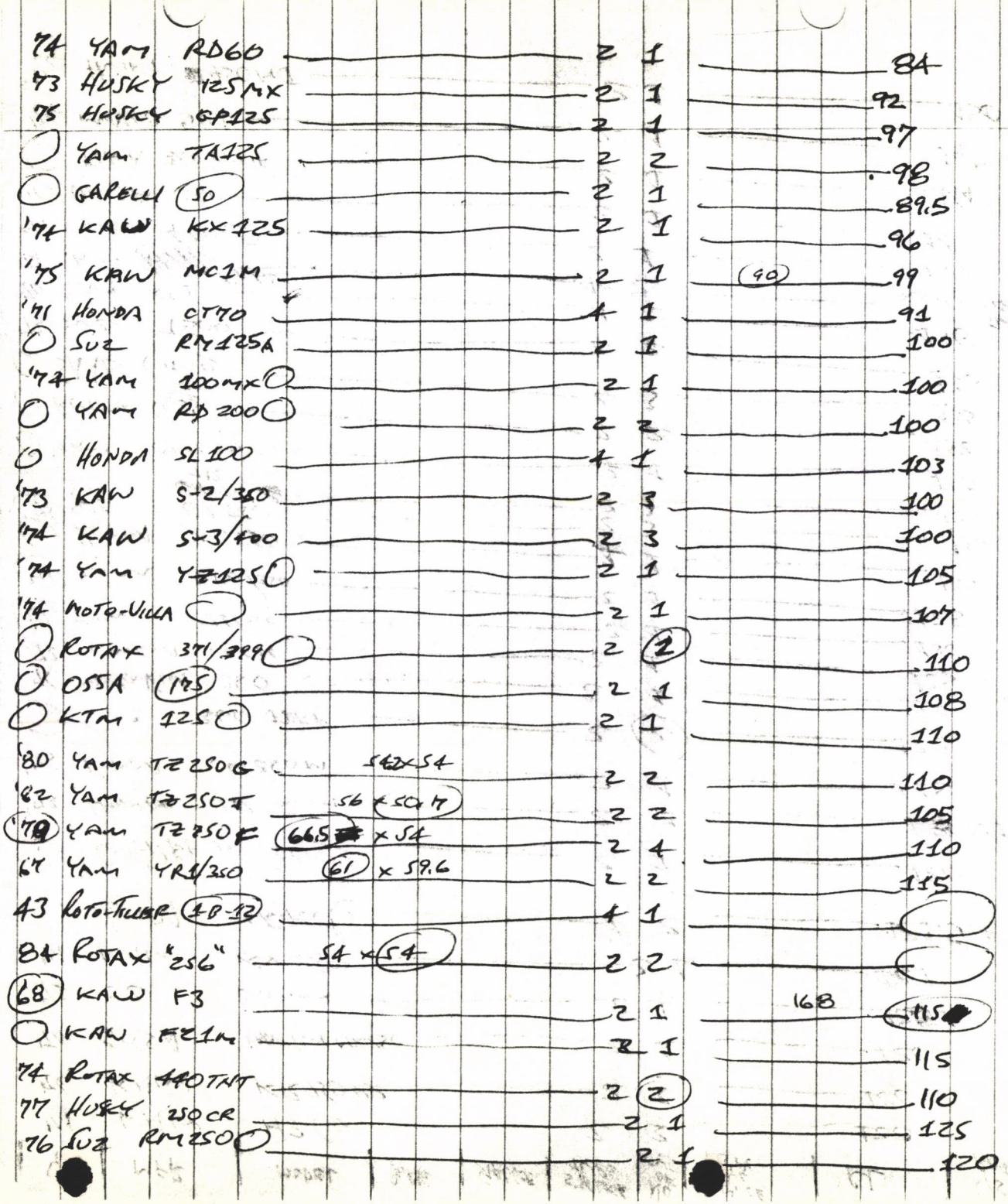
ROD ANGULARITY-TO-DISPLACEMENT SORTING TABLE

NO TITLE - JUST CONTINUED FM P. 59





60


'74 YAM RD60
'73 HUSKY 125MX
'75 HUSKY CP125
YAM TA125
GARELLI (50)
'74 KAW KX125
'75 KAW MC1M
'71 HONDA CT70
SUZ RM125A
'74 YAM 100MX
YAM RD200
HONDA SL100
'73 KAW S-2/350
'74 KAW S-3/400
'74 YAM YZ125
'74 MOTO-VILLA
ROTAX 371/399
OSSA (175)
KTM 125
'80 YAM TZ250G
'82 YAM TZ250T
'79 YAM TZ250F
'67 YAM YR1/350
43 ROTO-TILLER (10-12)
84 ROTAX "256"
(68) KAW F3
KAW FZ1M
'74 ROTAX 440TNT
'77 HUSKY 250CR
'76 SUZ RM250
54 x 54
56 x 50.7
66.5 x 54
61 x 59.6
2 1
84
92
97
98
89.5
96
(40) 99
91
100
100
100
103
100
100
105
107
2 (2)
110
108
110
110
105
110
115
168 115
115
110
125
120

Engine Building Tips and Specifications

BASIC ENGINE DIMENSIONS (INCHES)

Displacement	Years	Bore	Stroke	Bore Spacing	Main Journal Dia.	Rod Journal Dia.	Con Rod Length (Mean)	Crankshaft Center Line To Deck
1.0L Fiesta	1976-79				2.1257			
1.6L Kent	1971-73	3.188	3.056	3.780	3.1881	1.9372	4.9280	
1.6L CVH	1981-85	3.150	3.130	3.614	2.3830	1.8855	5.1945	8.212
1.9L CVH	1985	3.230	3.465					8.378
2.0L OHC①	1971-74	3.575	3.029	4.016	2.2436	2.0468	4.9820	
2.0L OHC②	1983-85	3.520	3.126	4.173	2.3986	2.0468	5.2047	8.368
2.3L OHC	1974-85	3.780						
2.3L HSC	1984-85	3.680	3.300	4.080	2.24895	2.1236	5.4570	8.700
2.6L V-6	1972-73	3.545	2.630	4.760	2.2437	2.1270		8.084
2.8L V-6	1974-80	3.650	2.700				5.1400	
3.8L V-6	1982-85	3.810	3.390	4.193	2.5194	2.3107	5.9135	9.232
170 I-6	1961-72	3.500	2.940					
200 I-6	1963-83	3.680	3.126	4.080	2.2486	2.1236	4.7150	7.808
250 I-6	1969-80		3.910		2.3986		5.8800	
240 I-6	1965-72	4.000	3.180	4.480	2.3986	2.1232	6.7947	10.000
300 I-6	1965-85		3.980				6.2097	
221	1962-63	3.50	2.870	4.380	2.2486	2.1232	5.1550	8.206
255	1979-82	3.680	3.000					
260	1962-64	3.800	2.870					
289	1963-68	4.00	3.000				5.0900	
302	1968-85							
302 BOSS	1969-70					2.1226	5.1500	8.201-8.21
302 SVO	③							
351W	1969-70		3.500		3.000	2.311	5.9860	9.480 (1969-70) 9.503 (1971-85)
351W SVO	③							9.503
351C SVO	③				2.749		5.7800	9.206
351C & BOSS	1970-74							
351M	1975-85				2.9998	2.3107	6.580	10.297
400	1971-81		4.000					10.292-10.302
352	1960-66	4.000	3.500	4.630	2.749	2.4380	6.5400	10.170
390	1961-71	4.050	3.780				6.4890	
406	1962-63	4.130						
410	1966-67	4.050	3.980					
427	1963-68	4.230	3.780					
428	1966-70	4.130						
429 STD	1968-73	4.360	3.590	4.900	3.000	2.500	6.6050	10.300 (1968-70) 10.310 (1970½-71) 10.322 (1972-73)
429 CJ/SCJ	1969-70							
429 BOSS (S)	1969						6.5490	10.300
429 BOSS (T)	1969-70						6.6050	
460	1969-85		3.850					

①Car ②Ranger/Bronco II ③Non-production blocks. Dimensions for reference.

NOTE: All 4-cylinder (except 1.6L Kent) and all V-6 engines are metric. Dimensions shown in inches.

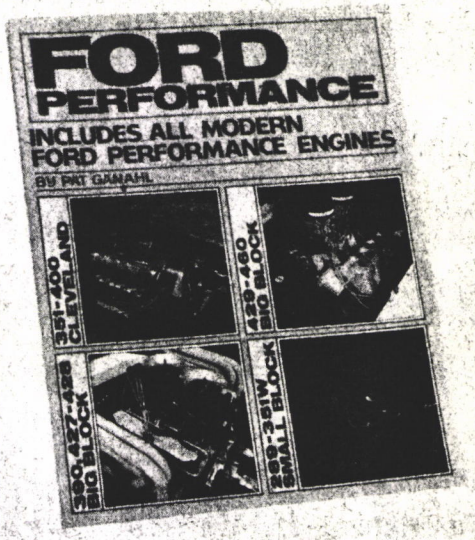
SMALL V-8 PARTS INTERCHANGE CHART

Components	BARE ENGINE BLOCKS																	
	CID 289/302 302 BOSS 302 SVO — Max. Bore Dia. 4.030" 4.030" 4.060"						CID 351W 351W SVO — Max. Bore Dia. 4.030" 4.060"						CID 351C 351C BOSS 351C SVO — Max. Bore Dia. 4.030" 4.030" 4.030"					
Cylinder Head	A	B	C	D	E	F	A	B	C	D	E	F	A	B	C	D	E	F
Intake Manifold	A	A	G	E	E	E	B	B	H	F	F	F	H	H	C	D	D	D
Head Gasket	C	C	B	B	B	B	C	C	B	B	B	B	A	A	A	A	A	A
Push Rod	A	E	F	F	F	F	B	B	D	D	D	D	G	G	C	C	C	C
Piston Design	A	A	B	B	B	B	A	A	B	B	B	B	A	A	B	B	B	B

"FORD PERFORMANCE" ENGINE BUILDERS MANUAL

NEW **M-1832-A1**

- So good, so authoritative, we put a part number on it.
- Covers four modern Ford V-8 engine families, 128 pages.
- Detailed "how to" performance modifications, specifications, part numbers and interchange data.
- Review of current performance equipment.



SMALL V-8 INTERCHANGE NOTES

The parts interchange chart shows recommended component combinations for three block designs (289/302, 351W and 351C) along with maximum bore diameters. For example, if cylinder head "D" (M-6049-A3) is used on a 289/302, 302 BOSS, or 302 SVO block . . . then read down the fourth column . . . to additional recommended components, intake manifold "E" (M-9424-B302), head gasket "B" (M-6051-A331), push rod "F" (M-6565-B322) and piston design "B" (canted valve reliefs).

CYLINDER HEADS (6049)
- A. 289/302
- B. 351W
- C. 302 BOSS/351C/ 351C BOSS
- D. M-6049-A3
- E. M-6049-B351
- F. M-6049-C302

INTAKE MANIFOLD (9424)
- A. 289/302
- B. 351W
- C. 351C
- D. M-9424-A331
- E. M-9424-B302
- F. M-9424-A351
- G. 302 BOSS
- H. Non-Ford, or Spacers

HEAD GASKET (6051)
- A. M-6051-A341
- B. M-6051-A331
- C. M-6051-A302

PUSH RODS (6565)
- A. M-6565-A312
- B. M-6565-A332
- C. M-6565-C342
- D. M-6565-D342
- E. M-6565-C332
- F. M-6565-B322
- G. Custom Length

PISTON DESIGN (6108)
- A. • In-Line Valve Reliefs
  - • Pin Location — As Required
  - • Dome/Dish — As Required
- B. • Canted Valve Reliefs
  - • Pin Location — As Required
  - • Dome/Dish — As Required

Engine Building Tips and Specifications

CYLINDER HEAD WATER PASSAGE MODIFICATION

As described on page 15, cylinder heads for 351C/351M/400 engines have a water outlet passage in the combustion face, whereas 289/302/351W heads have a water outlet passage in the intake manifold face of the head. Heads can be interchanged . . . if provision is made for appropriate water passages.

HERE ARE THE RULES:

To install Windsor type heads (289/302/302 BOSS/351W) on a Cleveland type block (351C/351M/400)

1. Drill a 11/16" dia. hole in the combustion face of the head, using Cleveland type head gasket for template. Be sure to clean out all shavings and metal particles.
2. Install heads with Cleveland type head gasket. Intake manifold gasket must match intake manifold.

To install Cleveland type heads (351C/351M/400) on a Windsor type block (289/302/302 BOSS/351W)

1. Drill a 0.800" dia. hole in the intake manifold face of the head as illustrated.
2. Plug square hole in cylinder head. Install heads with Cleveland type head gasket.
3. Use intake manifold gasket to match intake manifold.

NOTE: If BOSS type heads (302 or 351C) are used in either procedure, remember they have larger rounded ports than conventional heads; thus a unique BOSS type intake manifold gasket is required.

. . . And If You Have 302/351 SVO Aluminum Heads?

These heads come with a tapped 3/4" pipe thread hole in the combustion face, but no hole in the intake manifold face.

NOTE: SVO heads produced after July, 1984 also have a 3/4" pipe thread in both the front and rear ends of the head . . . to permit usage SVO External Water Outlet Kit M-8594-A351 (page 26) which is required with some SVO competition intake manifolds.

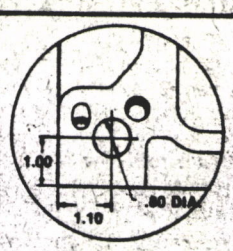
To install a Windsor type block (289/302/302 BOSS/351W)

1. Install pipe plug in hole. Finish so it doesn't protrude above head face.
2. Drill a 0.800" dia. hole in the intake face as shown . . . or . . . use the 3/4" pipe thread external water outlet valve provided in the front and rear ends of SVO heads produced after July, 1984.

To install on Cleveland type block (351C/351M/400)

1. Requires no special head work.

Windsor Head on Cleveland Block

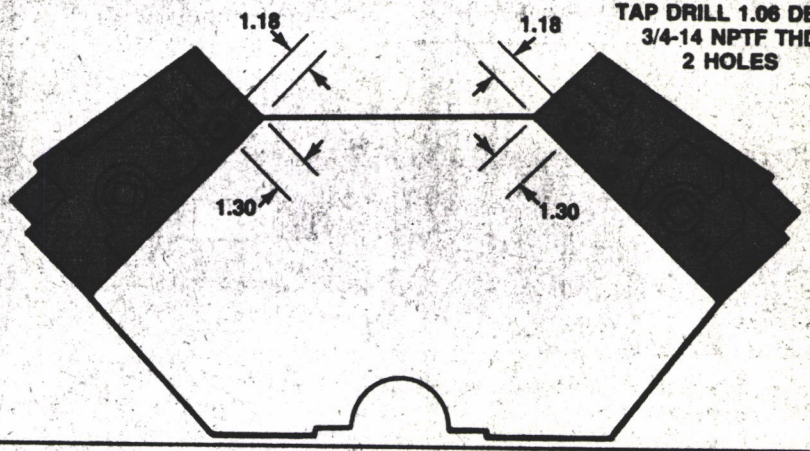


Water Transfer Hole Location For 289/302/302 BOSS/351W

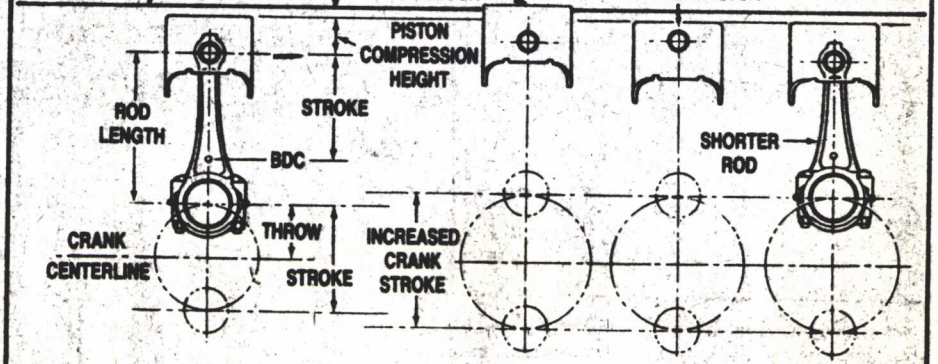
Combustion Face — SVO Head

Intake Face — SVO Head

TYPICAL MOTORSPORT ALUMINUM HEADS DRILLED & TAPPED FOR EXTERNAL WATER OUTLETS



BORING AND STROKING FUNDAMENTALS



1 — Crank throw times two equals stroke. Changing rod length or piston compression height only changes where stroke occurs in cyl. bore — not length of stroke.

2 — Use of crank with longer stroke and stock rods results in stock piston being above top of block. Requires shorter rod or new piston pin location.

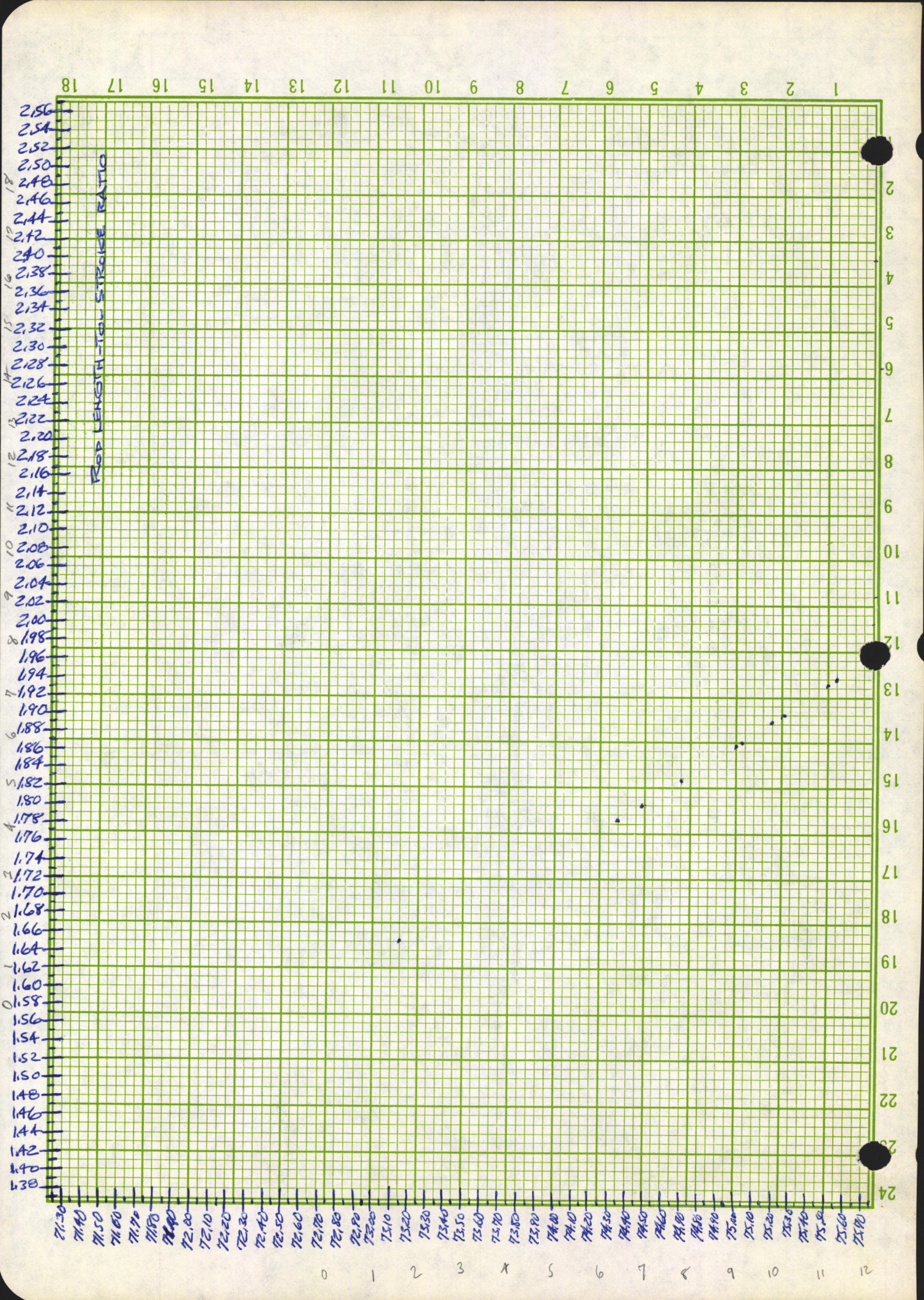
3 — Re-located piston pin.

4 — Shorter rod.

YR	MFR	MODEL	BORE	STROKE	STROKE TYPE	NO OF CYL	SINGLE CYL DISPL	RL	B/S RATIO	RL/S RATIO	ROD L @ 90°
74	KAW	H2			2	3		120			
76	KAW	KR750RR			2	3		120			
74	OSSA	PHANTOM MK250			2	1		120			
74	CZ	250 mx			2	1		120			
74	KAW	KX 250			2	1		121			
( )	HONDA	CB400 (?)			4	2		121.5 (.4) ?			
74	CARABELA	200			2	1		120			
'73	HONDA	CR250M			2	1		121			
'75	HONDA	CR250M			2	1		125			
( )	SUZ	360 JEEP			2	(2)		122			
75	MOTO-VELLA	250			2	1		124			
73	YAMAHA	SC500			2	1		125			
(67)	YAM	DT1/250			2	1		130			
(74)	YAM	DT2/250			2	1		125			
( )	HONDA	XL250			4	1		125			
(75)	SUZ	GT 750			2	3		130			
(75)	SUZ	~~GT 750~~ TR			2	3		130			
( )	YAM	GX400D			2	1		130			
( )	ROTAX	(635)			2	2		132			
( )	SAAB	(AUTO)			2	3		135			
73	SUZ	T500			2	2		136			
70	YAM	XS1			4	2		136			
74	YAM	~~XS650~~ TX650			4	2		(130) OK	SHORT ROD		
74	MAICO	400 ( )			2	1		137			
73	VILLERS	250			2	1		140			
( )	JAWA	350 CALIF.			2	1		144			
'74	MAICO	501			2	1		147			
'72	HUSKY	~~450~~ MJ			2	1		150			

YR	MFR	MODEL	BORE	STROKE	2S 4S	TWIN TRIPLE FOUR SIX EIGHT	SINGLE CYL DIS	RL	B/S RATIO	RL/STROKE RATIO	ROD L @ 90°
82	YAM	YZ250J			2S	SINGLE		125			
83	YAM	YZ250K			2S	SINGLE		130			
76	YAM	RD400	64	62	2S	TWIN		115			
76	MAICO	AW250			2S	SINGLE		131.625			
( )	HODAKA	125 (?)			2S	SINGLE		100			
( )	YAM	100 (?)			2S	SINGLE		100			
( )	MOTO-VILLA	(?)	(85)	x (68)	2S	SINGLE		(121)			
82	SUZ	RM250 ( )			2S	SINGLE		120			
76	SUZ	GT380 ( )			2S	TRIPLE		110			
74-78	HON	CR125M			2S	SINGLE		100			
( )	VINCENT	BLACK SHADOW			4S	TWIN		184.2125			
(76)	KAW	~~F7~~ 125 ~~S3~~ (?)			2S	SINGLE		110			
( )	INDIAN	( ) BAMBINO			2S	SINGLE		76.8125			
79	SUZ	RM80 (3)	49	x 42	2S	SINGLE		89.7875			
( )	KAW	JS440 ( )			2S	TWIN		110			
74	SUZ	RL250L			2S	SINGLE		120.855			
80	YAM	TZ125G			2S	SINGLE		105			
( )	SUZ	PE175		x 57	2S	SINGLE		112.885			
'74	HON	CB500 (T)			4S	TWIN		116			
78	YAM	YZ80E			2S	SINGLE		84			
'79	SUZ	RM125N			2S	SINGLE		100			
(74)	DUCATI	750SS			4S	TWIN		150			
( )	BMW	R50 (US)			4S	TWIN		125			
( )	BMW	R60/5			4S	TWIN		125			
( )	BMW	R69			4S	TWIN		130			
(78)	DUCATI	900SS			4S	TWIN		145			
78	KAW	KX125A4			2S	SINGLE		106			
(65)	DUCATI	(DIANA)			4S	SINGLE		125			

YR	MFR	MODEL	BORE	STROKE	STROKE TYPE	NO. OF CYLS	SINGLE CYLINDER DISPLACE.	RL	B/S RATIO	RL/S RATIO	ROD L @ 90°
82	YAM	YZ125T			2	1		98			
78 79	KTM	400			2	1		125			
74	H-D	SX175			2	1		115			
75	KTM	250 MX/T SCRAMBLER			2	1		124.5			
77	KTM	400 MCS			2	1		126			
76	KTM	250 #54			2	1		125.5			
68	DUCATI	~~350 Desmo~~ SCRAMBLER			4	1		135			
77	BUL	MK ~~X~~ 9 PURSANG ~~10~~			2	1		116			
○	AJS	250 STORMER			2	1		127			
○	HONDA	600 AUTO			4	2		143.75 OK			
75	BUL	370 FRONTERA			2	1		116			
96	ITAL-JET	X50R			2	1		85			
76	YAM	KT-100S			2	1		100			
70	BRIDGESTONE	○			2	2		100			
76	MOTO-VILLA	○	78	85	2	1	142.6	140			
○	SUZUKI	550 GT			2	3		116.6			
69	TOYOTA	3KC	75	61	4	4		113			
75	LAVERDA	SF 750			4	2		145.5			
○	BMW	R75	82.○	70.6	4	2		135			
○	JAP	MK #4	84	99	4	2		216			
74	BUL	125 MARK VII			2	1		116			
83	YAM	~~YZ~~ 490 K			2	1		137.5			

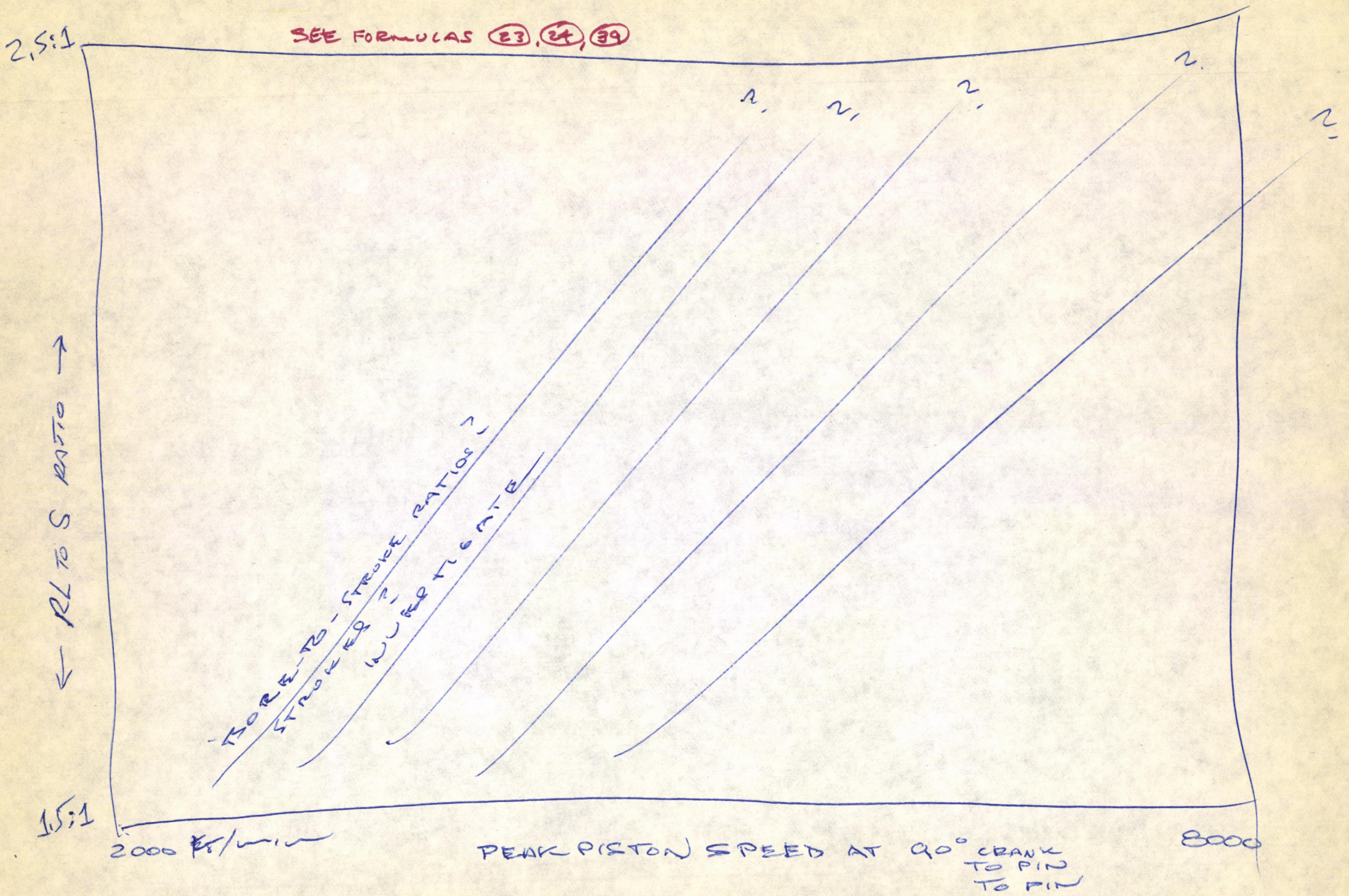

ROD LENGTH-TO-STROKE RATIO

SEPT '74

CRANK ANGLE AT BC WHEN CRANK ℄ TO PIN ℄ TO PIN ℄ = 90°

(14)

SEE FORMULAS (23), (24), (39)



LEFT

GENERAL NOTES (& DISCUSSION)

- REF TI-30II CALCULATOR
- PRESSURE ON DIAL INDICATOR (ROLL BACK & FORTH ACROSS TDC FOR EXAMPLE OF NON-SENSITIVITY OF DIAL INDICATOR

- WRIST PIN OFFSET

- (PICK OUT INFO FROM MY 2-STROKE FORMULAS TITLE PAGE OF MY ORIG. WORKSHEET) - FOR ADDITIONAL ITEMS

- GAS (OCTANE), TIMING, RPM AFFECTS

RIGHT

GEN NOTES (CONT.)

- TIME/RANGE/AREA OF PORTING

- TRANSFER ROOF ANGLES (NOTES AS TO YAMAHA SAE PAPER), CAMBEON YZR500 & RG500 ARTICLES, ETC

- FACTORY A DOES GENERACCY THEIR/ BASIC ENGINE HOME WORK

52

50

VEET

- REED BLOCKS/CAGES

- PIPES

- KEEP VERY CLOSE TRACK & DETAILED NOTES OF YOUR WORK.

WHEN YOU HAVE FINISHED BUILDING A SUCCESSFUL ENGINE & IF YOU RUN ~~[illegible]~~ A FINAL 40-PAGE PRINTOUT, DON'T FORGET TO ~~INCLUDE~~ ADD A DETAILED WORKSHEET & DRAWING DEFINING & SHOWING SUCH THINGS AS PORT WIDTHS, PORT CORNER RADIUS, EXIT & ENTRY ANGLES, ~~RE~~ AND PORT LENGTHS.

5/1 43

GEN BOOKLET NOTES

6/84 V. HIGH EXH (OR HIGHER) MOVES PK TORQUE CLOSER TO PK HP.

20 Squares to the Inch

NATIONAL 12-282 MADE IN U.S.A.

15000 : 1 = 71.5651°

25000 : 1 = 78.6901°

QUICK REFERENCE CHART FOR MAXIMUM PISTON VELOCITY OCCURENCE FOR A GIVEN RANGE OF ROD LENGTH TO STROKE RATIOS

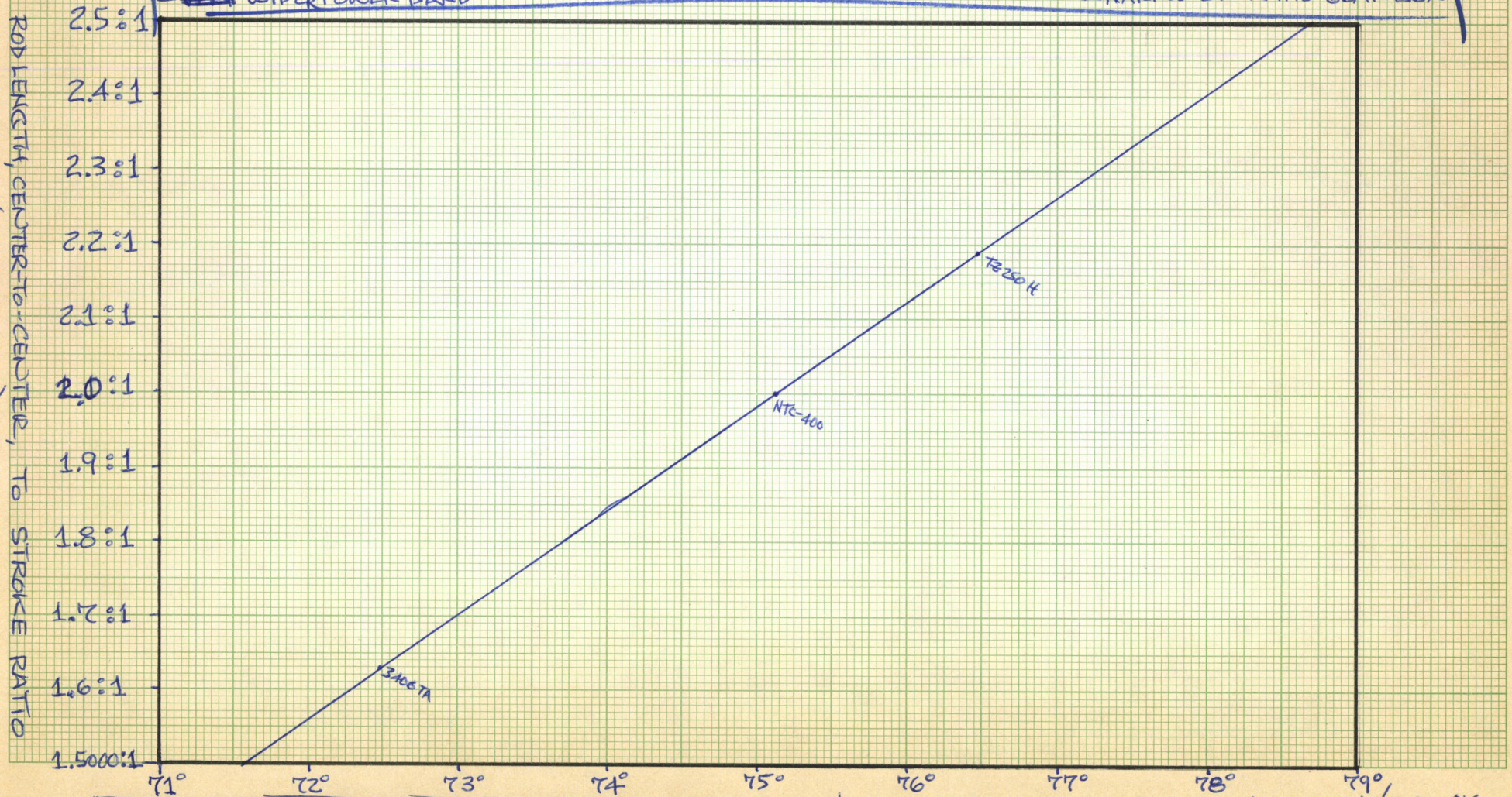
8513 CID (6 cyl) CUMMINS NTC-400/FORMULA 400
1250 LB/FT TORQUE = 1.4615 LB/FT/CUIN.
400 BHP = .4677 BHP/CU.IN.

GEN. RULES OF THUMB FOR 2 & 4 STROKE ENGINES:

- LOWER HORSEPOWER PER UNIT OF DISPLACEMENT
- ~~VERY HIGH TORQUE MOTORS PER UNIT OF DISPLACEMENT~~
- LARGER SPREAD BETWEEN PEAK TORQUE RPM & PEAK HORSEPOWER RPM
- WIDER RATIO GEARBOX
- PEAK TORQUE RPM OCCURS AT LOWER MEAN PISTON SPEED
- WIDER POWER BAND

- HIGHER HORSEPOWER PER UNIT OF DISPLACEMENT
- PEAK TORQUE RPM OCCURS AT HIGHER MEAN PISTON SPEED
- SMALLER SPREAD BETWEEN PEAK TORQUE RPM & PEAK HORSEPOWER RPM
- NARROWER POWER BAND
- NARROWER RATIO GEARBOX

3406TA CATAPILLER IS SAME 1265 LBS/FT



~~DEGREES PISTON VELOCITY BTDC~~ DEGRESS BTDC & ATDC FOR MAXIMUM PISTON VELOCITY OCCURENCE (ASSUMING CTRD WRIST PIN)

3/1/85

3/6/85

2-STROKE COMPRESSION RATIO

DISCUSSION:

1. MENTION THAT AS CYLINDER SIZE INCREASES, AND/OR, AS EXHAUST PORT TIMING BECOMES MORE MILD IN PORT-OPEN% DURATION, THE MORE ACCURATE WILL BE MOST COMPRESSION RATIO ~~CALCULATION~~ MEASUREMENTS AND CALCULATIONS

2. USE CLAY, INSTALL HEAD & TORQUE, REMOVE & ICE BOX THE CLAY, & THEN MEAS. TOC-TDC.

3. MEAS TOC-TDC USING PISTON & ~~RING~~ MARKED BTH. BORE WALL FM TOC TO TOP RING MARK

4. LENGTH OF SOME KEY-IN FORMULAS BECAUSE THEY MAY BE COLLECTION OF SEVERAL ~~SORTING~~ SHORTER, BUT COMPLETE, FORMULAS

5. COMPRESSION TEST W/ GAUGE; CRANKING COMPRESSION PRESSURE CHECKING

6. PISTON DOME/CROWN HEIGHT MEAS'D W/ TH PISTON UPSIDE DOWN ON FLAT SURFACE.

7. THE RELATIVENESS OF ONE'S MEAS. MIGHT NOT BE PRECISE, BUT IS RELATIVE TO ONE'S METHODS

8. GENERAL RULES OF THUMB ABOUT COMPRESSION RATIOS

RIGHT PAGE

3/6/85

Discussion:

CONTINUED

W/ MY OR DOUBLE-COLUMN

COMPARATIVE CHART

ON NEXT FACING PAGE

LEFT PAGE

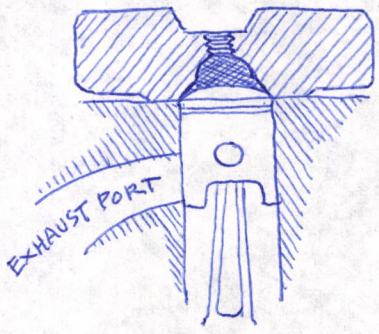
3/6/85

2-STROKE COMPRESSION RATIO

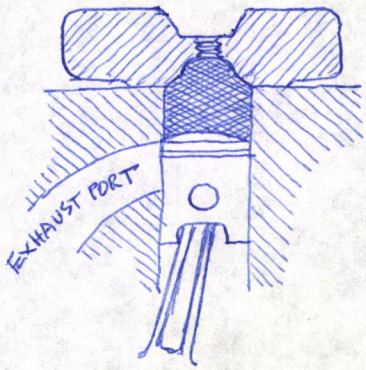
A. WHEN TRAPPED CYLINDER AND CYLINDER HEAD VOLUME IS KNOWN, WITH PISTON AT MOMENT EXHAUST PORT IS ABOUT TO BE OPENED, AND

B. WHEN TRAPPED CYLINDER HEAD VOLUME IS KNOWN, WITH PISTON AT TDC.

C. ALL VOLUME MEASUREMENTS TO BE IN CC'S.



VOLUME MEASURED WITH PISTON AT TDC



VOLUME MEASURED WITH PISTON AT MOMENT OF EXHAUST PORT OPENING

(SWAP DRAWINGS)

$$\text{COMPRESSION RATIO} = \frac{\text{TRAPPED CYLINDER AND CYLINDER HEAD VOLUME}}{\text{TRAPPED CYLINDER HEAD VOLUME}} \text{ to } 1$$

GIVEN: YEAR/MANUFACTURER/MODEL [ ]

1. MEASURED TRAPPED CYLINDER HEAD VOLUME, WITH PISTON AT TDC, VOLUME CC'D UP TO BOTTOM OF SPARK PLUG HOLE.....TCHV = [ ] CC

(SWAP)

2. MEASURED TRAPPED CYLINDER AND CYLINDER HEAD VOLUME, WITH PISTON LOCKED AT MOMENT OF EXHAUST PORT OPENING, VOLUME CC'D UP TO BOTTOM OF SPARK PLUG HOLE.....TCV ~~TCHV~~ = [ ] CC

ENTER:

MEASURED TRAPPED CYLINDER AND CYLINDER HEAD VOLUME (TCV ~~TCHV~~)		MEASURED TRAPPED CYLINDER HEAD VOLUME (TCHV)		ANSWER
[ ]	÷	[ ]	=	[ ] CC

3/6/05

2-STROKE COMPRESSION RATIOS

SAMPLE PROBLEMS:

✓ TZ250 H

✓

✓

3/7/85

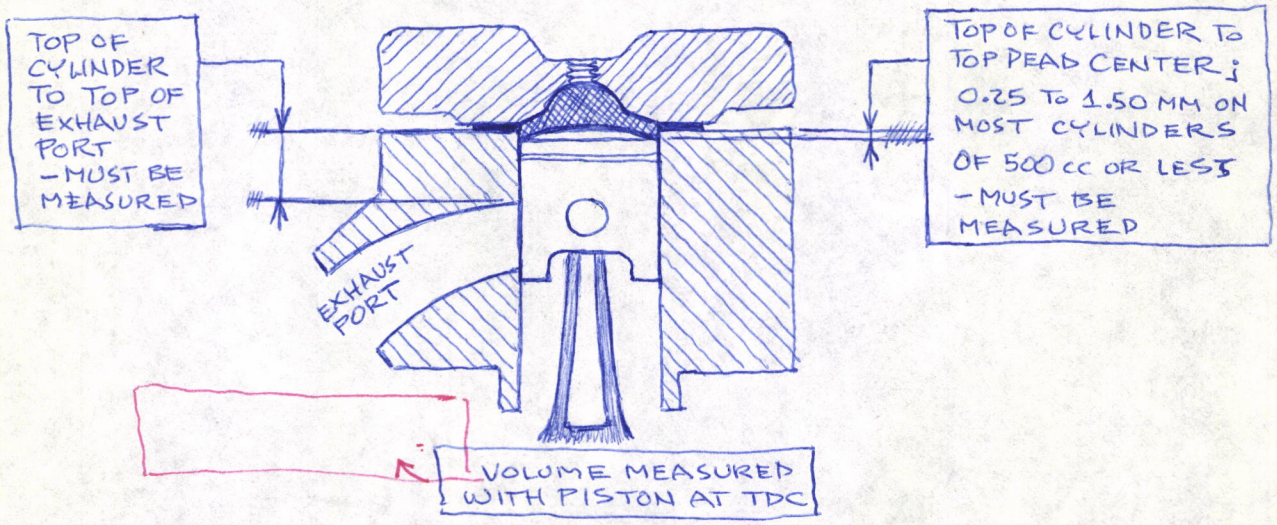
2-STROKE COMPRESSION RATIO

A. WHEN TRAPPED CYLINDER HEAD VOLUME IS KNOWN, WITH PISTON AT TDC, AND

B. WHEN CYLINDER BORE, TOP OF CYLINDER TO TDC, AND TOP OF CYLINDER TO TOP OF EXHAUST PORT DIMENSIONS ARE KNOWN.

C. TRAPPED CYLINDER HEAD VOLUME TO BE IN CC'S.

D. ALL DIMENSIONS TO BE IN MILLIMETERS.


TOP OF CYLINDER TO TOP OF EXHAUST PORT - MUST BE MEASURED
EXHAUST PORT
TOP OF CYLINDER TO TOP DEAD CENTER; 0.25 TO 1.50 MM ON MOST CYLINDERS OF 500 CC OR LESS - MUST BE MEASURED
VOLUME MEASURED WITH PISTON AT TDC

$$\text{COMPRESSION RATIO} = \frac{\text{CALCULATED CYLINDER VOLUME FROM TDC TO TOP OF EXHAUST PORT} + \text{TRAPPED CYLINDER HEAD VOLUME}}{\text{TRAPPED CYLINDER HEAD VOLUME}} \text{ to } 1$$

GIVEN: YEAR/MANUFACTURER/MODEL

1981 YAMAHA TZ250 TWIN ROAD RACER (FRED MERKEL'S)

1. TRAPPED CYLINDER HEAD VOLUME, WITH PISTON AT TDC, VOLUME CC'D UP TO BOTTOM OF SPARK PLUG HOLE ..... TCHV = 9.1 CC
2. BORE, CYLINDER ..... B = 56 MM
3. TOP OF CYLINDER TO TOP DEAD CENTER ..... TOCTDC = 0.25 MM
4. TOP OF CYLINDER TO TOP OF EXHAUST PORT (EXHAUST OPENING HEIGHT) ..... TOCEOH = 23.30 MM

ENTER:

TOP OF CYLINDER TO TOP OF EXHAUST PORT (TOCEOH)		TOP OF CYLINDER TO TOP DEAD CENTER (TOCTDC)			CYLINDER BORE (B)				
23.30	−	0.25	=	×	56	x^2	×	.7854	.....

		TRAPPED CYLINDER HEAD VOLUME (TCHV)			TRAPPED CYLINDER HEAD VOLUME (TCHV)		ANSWER	
÷	1000	+ 9.1	=	÷	9.1	=	7.2387343	to 1

3/6/85

2-STROKE COMPRESSION RATIOS

2 WORKING EXAMPLES

RIGHT PAGE

3/8/85

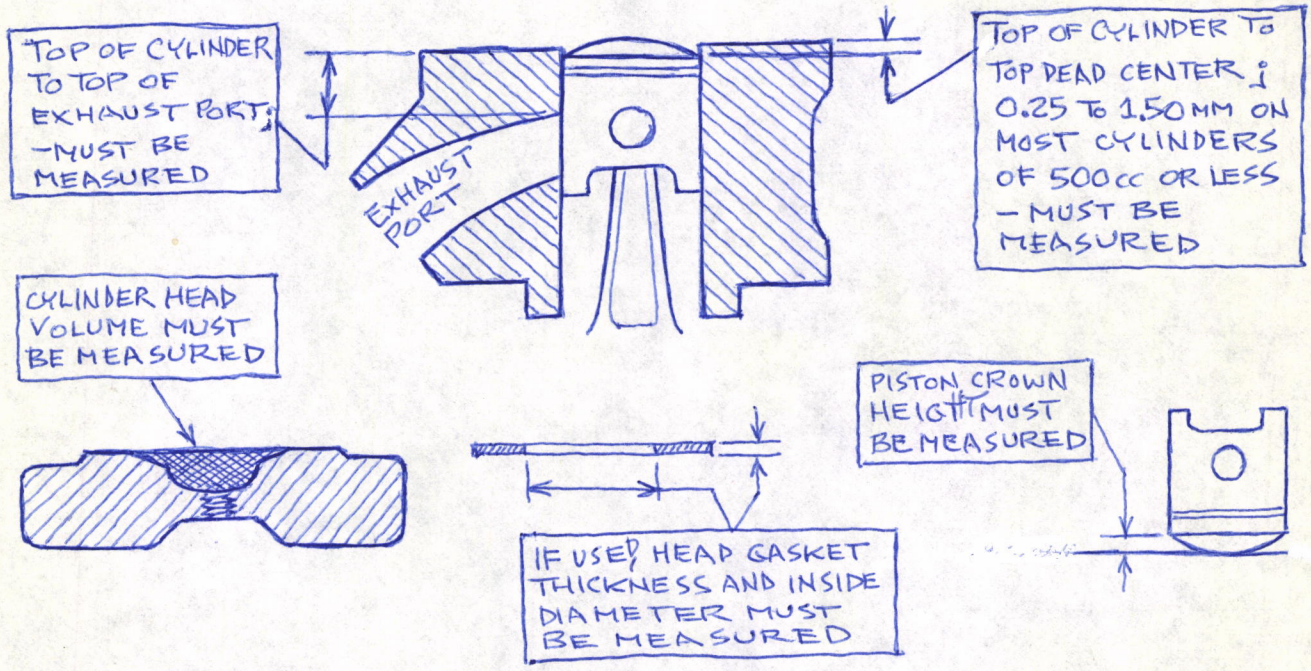
2-STROKE COMPRESSION RATIOS

A. WHEN MEASURED CYLINDER HEAD VOLUME IS KNOWN, AND

B. WHEN HEAD GASKET (IF USED) THICKNESS AND INSIDE DIAMETER, CYLINDER BORE, TOP OF CYLINDER TO TDC, TOP OF CYLINDER TO TOP OF EXHAUST PORT, AND PISTON CROWN HEIGHT DIMENSIONS ARE KNOWN.

C. MEASURED CYLINDER HEAD VOLUME TO BE IN CC'S.

D. ALL DIMENSIONS TO BE IN MILLIMETERS.


TOP OF CYLINDER TO TOP OF EXHAUST PORT - MUST BE MEASURED
EXHAUST PORT
TOP OF CYLINDER TO TOP DEAD CENTER: 0.25 TO 1.50 MM ON MOST CYLINDERS OF 500 CC OR LESS - MUST BE MEASURED
CYLINDER HEAD VOLUME MUST BE MEASURED
PISTON CROWN HEIGHT MUST BE MEASURED
IF USED, HEAD GASKET THICKNESS AND INSIDE DIAMETER MUST BE MEASURED

$$\text{CALCULATED COMPRESSION RATIO} = \frac{\text{CALCULATED CYLINDER VOLUME FROM TDC TO TOP OF EXHAUST PORT} + \text{CALCULATED CYLINDER VOLUME FROM TOP OF CYLINDER TO TDC} + \text{CALCULATED HEAD GASKET VOLUME} + \text{MEASURED CYLINDER HEAD VOLUME} - \text{CALCULATED PISTON CROWN VOLUME}}{\text{CALCULATED CYLINDER VOLUME FROM TOP OF CYLINDER TO TDC} + \text{CALCULATED HEAD GASKET VOLUME} + \text{MEASURED CYLINDER HEAD VOLUME} - \text{CALCULATED PISTON CROWN VOLUME}} \circ 1$$

LEFT PAGE

3/8/85

WORKING EXAMPLE:

GIVEN: YEAR/MANUFACTURER/MODEL

1981 YAMAHA TZ250H TWIN ROAD RACER (FRED MERKEL'S)

1. MEASURED CYLINDER HEAD VOLUME.....MCHV = **12.5** CC
2. CYLINDER BORE.....B = **56** MM
3. TOP OF CYLINDER TO TOP DEAD CENTER.....TOCTDC = **0.25** MM
4. TOP OF CYLINDER TO TOP OF EXHAUST PORT (EXHAUST OPENING HEIGHT)....TOCEOH = **23.30** MM
5. HEAD GASKE INSIDE DIAMETER.....HGID = **0** MM
6. HEAD GASKET THICKNESS.....HGT = **0** MM
7. PISTON CROWN HEIGHT.....PCH = **3.25** MM
8. FOR PISTON CROWN VOLUME, ENTER:

(PCH **3.25** x^2 x 4 + B **56** x^2 = ÷ .....

(8 x PCH **3.25**) =) = − (PCH **3.25** .....

÷ 3) = x PCH **3.25** x^2 x π ÷ 1000 = ...PCV = ANSWER **4.0203632** CC

FOR COMPRESSION RATIO, ENTER:

TOCEOH **23.30** − TOCTDC **.25** = x B **56** x^2 x .0007854 = ...

+ B **56** x^2 x TOCTDC **.25** x .0007854 = + HGID **0** .....

x^2 x HGT **0** x .0007854 = + MCHV **12.5** − PCV **4.02** .....

= STO B **56** x^2 x TOCTDC **.25** x .0007854 = + ...

HGID **0** x^2 x HGT **0** x .0007854 = + MCHV **12.5** .....

= − PCV **4.02** = 1/x x RCL = ANSWER **7.24** :1

LEFT PAGE

(REVISED FM 12/19/75 WORKSHEET) BRATTON CYCLES / P. 160 M-H

CALCULATED COMPRESSION RATIO =

$$\frac{\left[\frac{(B)^2\cdot(TOCEOH-TOCTDC)\cdot(.7854)}{1000}\right]+\left[\frac{(B)^2\cdot(TOCTDC)\cdot(.7854)}{1000}\right]+\left[\frac{(B)^2\cdot(TOCTDC)\cdot(.7854)}{1000}\right]+\cdots\cdots\cdots+\left[\frac{(HGID)^2\cdot(HGT)\cdot(.7854)}{1000}\right]+[MCHV]-\left[\frac{\pi\cdot(PCH)^2\cdot\left(\frac{B^2}{8}+\frac{PCH^2}{6}\right)}{1000}\right]}{\left[\frac{(HGID)^2\cdot(HGT)\cdot(.7854)}{1000}\right]+[MCHV]-\left[\frac{\pi\cdot(PCH)^2\cdot\left(\frac{B^2}{8}+\frac{PCH^2}{6}\right)}{1000}\right]}:1$$

GIVEN: YEAR/MANUFACTURER/MODEL [ ]

1. MEASURED CYLINDER HEAD VOLUME.....MCHV = [ ] CC
2. CYLINDER BORE.....B = [ ] MM
3. TOP OF CYLINDER TO TOP DEAD CENTER.....TOCTDC = [ ] MM
4. TOP OF CYLINDER TO TOP OF EXHAUST PORT (EXHAUST OPENING HEIGHT).....TOCEOH = [ ] MM
5. HEAD GASKET INSIDE DIAMETER.....HGID = [ ] MM
6. HEAD GASKET THICKNESS.....HGT = [ ] MM
7. PISTON CROWN HEIGHT.....PCH = [ ] MM
8. ENTER FOR PISTON CROWN VOLUME:
(FOR CONSTANT CROWN RADIUS ONLY)

[π] [×] [PCH] [ ] [×] [(] [B] [ ] [x²] [÷] .....

[8] [+] [PCH] [ ] [x²] [÷] [6] [)] [÷] [1000] [=] ...PCV = [ANSWER] [ ] CC

FOR COMPRESSION RATIO, ENTER:

[TOCEOH] [ ] [−] [TOCTDC] [ ] [=] [×] [B] [ ] [x²] [×] [.0007854] [=] .....

[+] [B] [ ] [x²] [×] [TOCTDC] [ ] [×] [.0007854] [=] [+] [HGID] [ ] .....

[x²] [×] [HGT] [ ] [×] [.0007854] [=] [+] [MCHV] [ ] [−] [PCV] [ ] .....

[=] [STO] [B] [ ] [x²] [×] [TOCTDC] [ ] [×] [.0007854] [=] [+] .....

[HGID] [ ] [x²] [×] [HGT] [ ] [×] [.0007854] [=] [+] [MCHV] [ ] .....

[=] [−] [PCV] [ ] [=] [1/x] [×] [RCL] [=] [ANSWER] [ ] :1

RIGHT PAGE

2-STROKE COMPRESSION RATIOS & CRANKING PRESSURE RELATIONSHIPS

PAGE 2

FOR 2-STROKES ONLY: the 2 columns below are used merely for comparison estimates only; they are only relative for each engine being altered - not from one engine to the next. When altering the porting (and/or compression) of an engine, first draw a straight line from a dot in the first column (see sheet titled "MATHEMATICAL CALCULATIONS OF 2-STROKE COMPRESSION RATIO") to a dot in the second column based on the stock engine calculations and actual cranking pressure. After altering the porting, select the desired cranking pressure you wish to obtain. Draw a line from the desired cranking pressure to (and parallel with the original "stock" line) the mathematically calculated compression ratio. On paper, alter the cc's of the head volume with the new exhaust port height until you arrive at the "new" calculated compression ratio. The cc's of the "new" ratio will be what you will want after machining and/or milling your stock head.

4.5:1 CR	100 LBS
4.6	102
4.7	104
4.8	106
4.9	108
5.0:1 CR	110 LBS
5.1	112
5.2	114
5.3	116 — 115 LBS
5.4	118
5.5:1 CR	120 LBS
5.6	122
5.7	124
5.8	126 — 125 LBS
5.9	128
6.0:1 CR	130 LBS
6.1	132
6.2	134
6.3	136
6.4	138
6.5:1 CR	140 LBS
6.6	142
6.7	144
6.8	146
6.9	148
7.0:1 CR	150 LBS
7.1	152
7.2	154
7.3	156
7.4	158
7.5:1 CR	160 LBS
7.6	162
7.7	164
7.8	166
7.9	168
8.0:1 CR	170 LBS
8.1	172
8.2	174
8.3	176
8.4	178
8.5:1 CR	180 LBS
8.6	182
8.7	184
8.8	186
8.9	188
9.0:1 CR	190 LBS
9.1	192
9.2	194
9.3	196
9.4	198
9.5:1 CR	200 LBS

ESTIMATED GOAL FOR MODIFIED HALF-MILER FOR ERIC ENGEN

STOCK YAM 124 SC 500 ESTIMATION

6.843

GENERAL NOTES:

1. Cranking pressure is usually best obtained by using a good screw in type compression gauge with the engine in gear, engine at hot operating temperature, and then pushed with the throttle full open.
2. Volumetric and mechanical efficiency are the 2 factors that have the most affect in variations of the relationship between ratios and compression.
3. Smaller engines are generally more efficient in both catagories of note #2 than larger engines (displacement per cylinder), resulting in slightly higher compressions with a given ratio.

6/4/84

LEET

MAXIMUM EXHAUST PORT OPENING HEIGHT FOR 2-STROKE ENGINE

DISCUSSION

FOR 2-STROKE CYLINDER TYPES:	
PISTON-PORT INTAKE	X
ROTARY-VALVE INTAKE	X
CYLINDER-REED INTAKE	X
CASE-REED INTAKE	X

DIAGRAMS

GIVEN:
1. ENGINE YEAR, MANUFACTURER, MODEL [ ]
2. STROKE = [ ] MM
3. ROD LENGTH = [ ] MM

TO SOLVE FOR MEOH, ENTER:

(STROKE ÷ 2) x^2 + ROD LENGTH x^2 = $\sqrt{x}$ +/- + ...

... (STROKE ÷ 2) + ROD LENGTH = ANSWER

MM FROM TDC TO THE TOP OF THE EXHAUST PORT OPENING

61

LEFT

MAXIMUM 2-STROKE EXHAUST PORT OPENING HEIGHT

FOR 2 STROKE ENG. WORK,

(CHANGE "MOST MOTORCYCLES = ~~0.00 ~ 1.~~ 0.0 ~ 1.5 mm"
~~MOTORCYCLE~~
~~2-STROKE ENGIN~~
TO
"MOST 2-STROKE ENGINES = 0.25 mm ~ 1.50 mm")

— SHORT DISCUSSION

— THEN DIAGRAMS

— THEN BLANK FORMULA
SENTENCE-BY-SENTENCE
WORK SHEET

2-STROKE
MAXIMUM EXHAUST PORT OPENING HEIGHT

RIGHT

– FILLED IN WORK SHEET FOR TI-30 II

TZ250H

– FILLED IN WORK SHEET FOR TI-30 II

YAMAHA TZ250

ROTAX 250 "256"

2 CONVERSION FROM LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

EXHAUST PORT | CENTERED WRIST PIN

FOR 2-STROKE CYLINDER TYPES:	
PISTON-PORT INTAKE	X
ROTARY-VALVE INTAKE	X
CYLINDER-REED INTAKE	X
CASE-REED INTAKE	X

DISCUSSION

DIAGRAMS

SEE P. 65

GIVEN: ENGINE YEAR/MANUFACTURER/MODEL

1981 ROTAX "256" 250 TWIN ROAD RACER

1. DISTANCE FROM TDC (NOT FROM TOP OF CYLINDER) TO EXHAUST OPENING HEIGHT, OR, TDC-EOH ..... 28.75 (MM)/INCH
2. STROKE ..... 54 MM/INCH
3. ROD LENGTH, CENTER-TO-CENTER ..... 106 MM/INCH

TO SOLVE FOR WHEN EXHAUST PORT OPENS ATDC, ENTER:

(STROKE 54 ÷ 2 + ROD LENGTH 106 − TDC-EOH 28.75) X² (10868) + (

STROKE 54 ÷ 2) X² (729) − ROD LENGTH 106 X² (11236) = ÷ 2 ÷ (180)

(STROKE 54 ÷ 2 + ROD LENGTH 106 − TDC-EOH 28.75) ÷ (1.73)

STROKE 54 ÷ 2) = (.06) INV COS ANSWER 86.322663 DEGREES ATDC WHEN EXHAUST PORT OPENS

& DEGREES BTDC WHEN EXH PORT CLOSES

TO SOLVE FOR TOTAL EXHAUST PORT OPEN DURATION, ENTER:

360 − (2 X DEGREES ATDC EXHAUST OPENS 86.322663 .....

.....) = ANSWER 187.35467 DEGREES OF TOTAL EXHAUST OPEN DURATION

DICK - DON'T REMEMBER SHOWING YOU ONE OF THESE

RIGHT

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

EXHAUST PORT

2 WORKING EXAMPLES

'81 " TZ250H"

" 1943 ROTOTILLER "

3/1/85

2.

CONVERSION FROM LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

TRANSFER PORT – CENTERED WRIST PIN

FOR 2-STROKE CYLINDER TYPES:

PISTON-PORT INTAKE	X
ROTARY-VALVE INTAKE	X
CYLINDER-REED INTAKE	X
CASE-REED INTAKE	X

DISCUSSION

USE HIGHEST TRANSFER .05 MEAS. INPUT ?

DIAGRAMS

BORDER EUM.?

GIVEN:

ENGINE YEAR/MANUFACTURER/MODEL

1. STROKE ..... MM/INCH
2. ROD LENGTH, CENTER-TO-CENTER ..... MM/INCH
3. DISTANCE FROM TDC (NOT FROM TOP OF CYLINDER) TO TRANSFER OPENING HEIGHT, OR, TDC-TOH ..... MM/INCH

TO SOLVE FOR WHEN TRANSFER PORT OPENS ATDC, ENTER:

(STROKE ÷ 2 + ROD LENGTH − TDC-TOH) x^2 + ...

... (STROKE ÷ 2) x^2 − ROD LENGTH x^2 = ÷ 2 ÷ .....

. (STROKE ÷ 2 + ROD LENGTH − TDC-TOH) ÷ .....

. (STROKE ÷ 2) =

. INV COS (RECIPS) ANSWER

DEGREES ATDC WHEN EXHAUST PORT OPENS
DEGREES BTDC WHEN EXHAUST PORT CLOSES

TO SOLVE FOR TOTAL EXHAUST PORT OPEN DURATION, ENTER:

DEGREES ATDC TRANSFER OPENS x 2 = +/− + 360 = ANSWER DEGREES OF TOTAL TRANSFER OPEN DURATION

RIGHT

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

TRANSFER PORT

2 WORKING EXAMPLES

'81 "TZ250H"

"'43 ROTO-TILLER"

3/1/85

2 CONVERSION FROM LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

INTAKE PORT – CENTERED WRIST PIN

FOR 2-STROKE CYLINDER TYPES:	
PISTON-PORT INTAKE	X
ROTARY-VALVE INTAKE	X
CYLINDER-REED INTAKE	X
CASE-REED INTAKE	X

DISCUSSION

DIAGRAMS

SEE 1.65

(SHOW PISTON MEASUREMENT)

GIVEN:

ENGINE YEAR/MANUFACTURER/MODEL: 1981 YAMAHA TZ250H

1. DISTANCE FROM TDC (NOT FROM TOP OF CYLINDER) TO INTAKE OPENING BOTTOM, OR, TDC-IOB ..... 87.75 MM/INCH
2. PISTON SKIRT LENGTH OF INTAKE SIDE, OR PSL ..... 53.75 MM/INCH
3. STROKE ..... 50.7 MM/INCH
4. ROD LENGTH, CENTER-TO-CENTER ..... 105 MM/INCH

TO SOLVE FOR WHEN INTAKE PORT OPENS BTDC, ENTER:

(STROKE 50.7 ÷ 2 + ROD LENGTH 105 − (TDC-IOB 87.85 − PSL 53.75 .....

.....)) x^2 + (STROKE 50.7 ÷ 2) x^2 − ROD LENGTH 105 .....

..... x^2 = ÷ 2 ÷ (STROKE 50.7 ÷ 2 + ROD LENGTH 105 − .....

..... (TDC-IOB 87.85 − PSL 53.75)) ÷ (STROKE 50.7 ÷ 2) .....

..... = INV COS ANSWER 103.24814 DEGREES BTDC WHEN INTAKE PORT OPENS
DEGREES ATDC WHEN INTAKE PORT CLOSES

TO SOLVE FOR ~~[illegible]~~ TOTAL INTAKE PORT OPEN DURATION, ENTER:

DEG BTDC INTAKE OPENS 103.24814 × 2 = ANSWER 206.49628 DEGREES OF TOTAL INTAKE OPEN DURATION

103.00218 206.00436

LEFT PAGE 67

Conversion of Linear Cylinder Measurements To Rotational Crankshaft Degrees

R16HT

Intake Port

2 working examples

1. '89 Yamaha TZ250H"

2. '43 Roto-Tiller

LEFT

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

INTAKE PORT

ROTARY-VALVE INTAKE

FOR 2-STROKE CYLINDER TYPES:	
PISTON-PORT INTAKE	●
ROTARY-VALVE INTAKE	X
CYLINDER-REED INTAKE	●
CASE-REED INTAKE	X

DISCUSSION

DEGREE WHEEL / DIAL INDICATOR WORK

CASE-REED INTAKE

DISCUSSION

- OPEN UP CASE — (5)
- LARGER X-SECTION REED BLOCK (2)
- LARGER CARBS — (1)
- DIFF REED STOPS — (3)
- BEND REED STOPS — (4)

RIGHT

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

INTAKE PORT

- ROTARY-VALVE INTAKE
(TYPICAL WORKSHEET EXAMPLE) 80°

WORK DONE

↓ OR → DEGREE WHEEL/DIAL INDICATOR RESULTS

RESULTS OF WORK

CASE-REED INTAKE
(TYPICAL WORKSHEET EXAMPLE) 0°

WORK DONE

RESULTS OF WORK

3/4/85

2 CONVERSION FROM ROTATIONAL CRANKSHAFT DEGREES TO LINEAR CYLINDER MEASUREMENTS

EXHAUST PORT | CENTERED WRIST PIN

FOR 2-STROKE CYLINDER TYPES:

PISTON-PORT INTAKE	X
ROTARY-VALVE INTAKE	X
CYLINDER-REED INTAKE	X
CASE-REED INTAKE	X

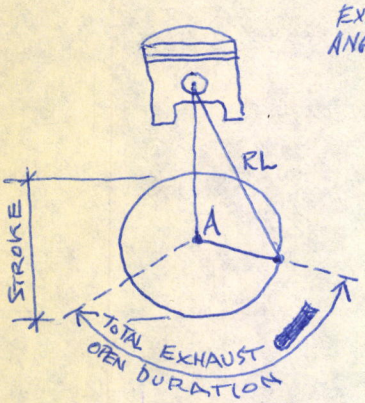
DISCUSSION

EXPLAIN ANGLE A

IF ONLY THE TOTAL EXHAUST PORT OPEN DURATION IS KNOWN, DO THIS FIRST; ENTER:

DEGREES OF TOTAL EXHAUST OPEN DURATION

360 − [ ] = ÷ 2 = [ANSWER] DEGREES OF ANGLE A



GIVEN:

ENGINE YEAR/MANUFACTURER/MODEL

1. STROKE = [ ] MM/INCH
2. ROD LENGTH = [ ] MM/INCH
3. ANGLE A = [ ] DEGREES ATDC WHEN EXHAUST PORT OPENS

TO SOLVE FOR MEASUREMENT FROM TDC TO TOP OF EXHAUST PORT, ENTER:

ANGLE A [ ] SIN X (STROKE [ ] ÷ 2) ÷ ROD LENGTH [ ] = ...

INV SIN + ANGLE A [ ] = +/− + 180 = SIN X ROD LENGTH [ ] .....

÷ ANGLE A [ ] SIN = +/− + (STROKE [ ] ÷ 2) .....

+ ROD LENGTH [ ] = ANSWER [ ] MM/INCH MEASUREMENT FROM TDC TO TOP OF EXHAUST PORT

3/4/85

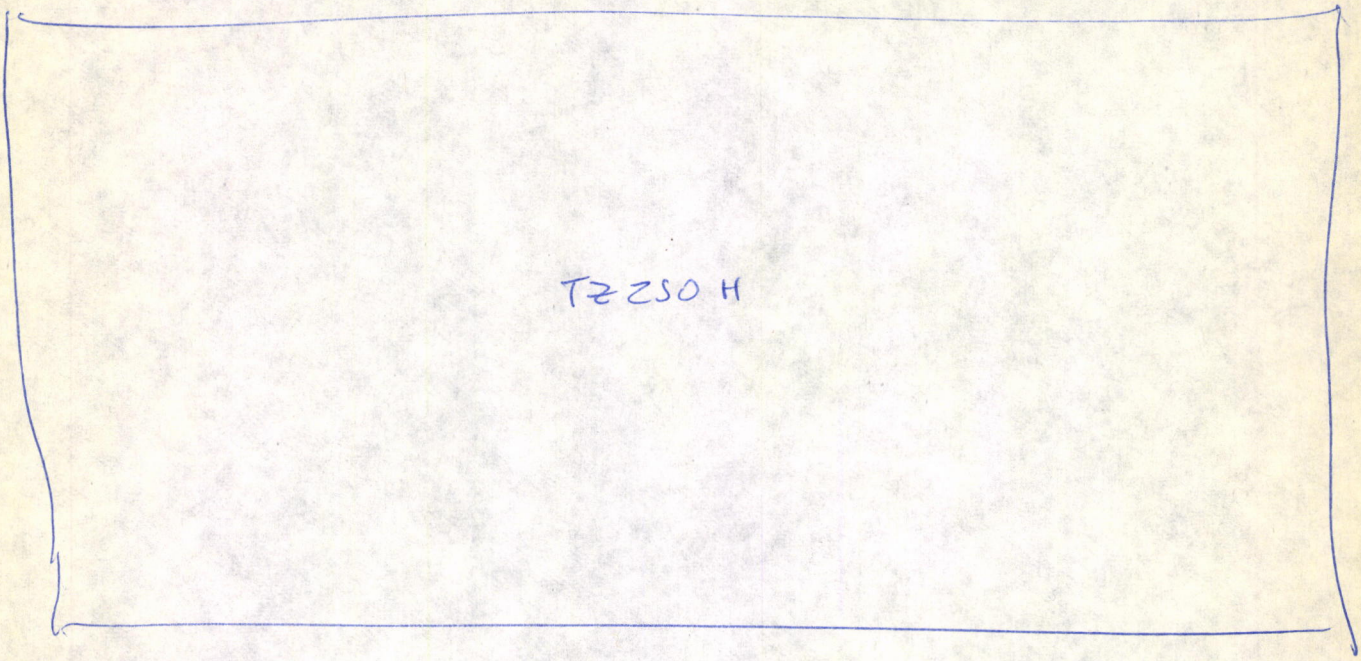
CONVERSION FROM ROTATIONAL CRANKSHAFT DEGREES

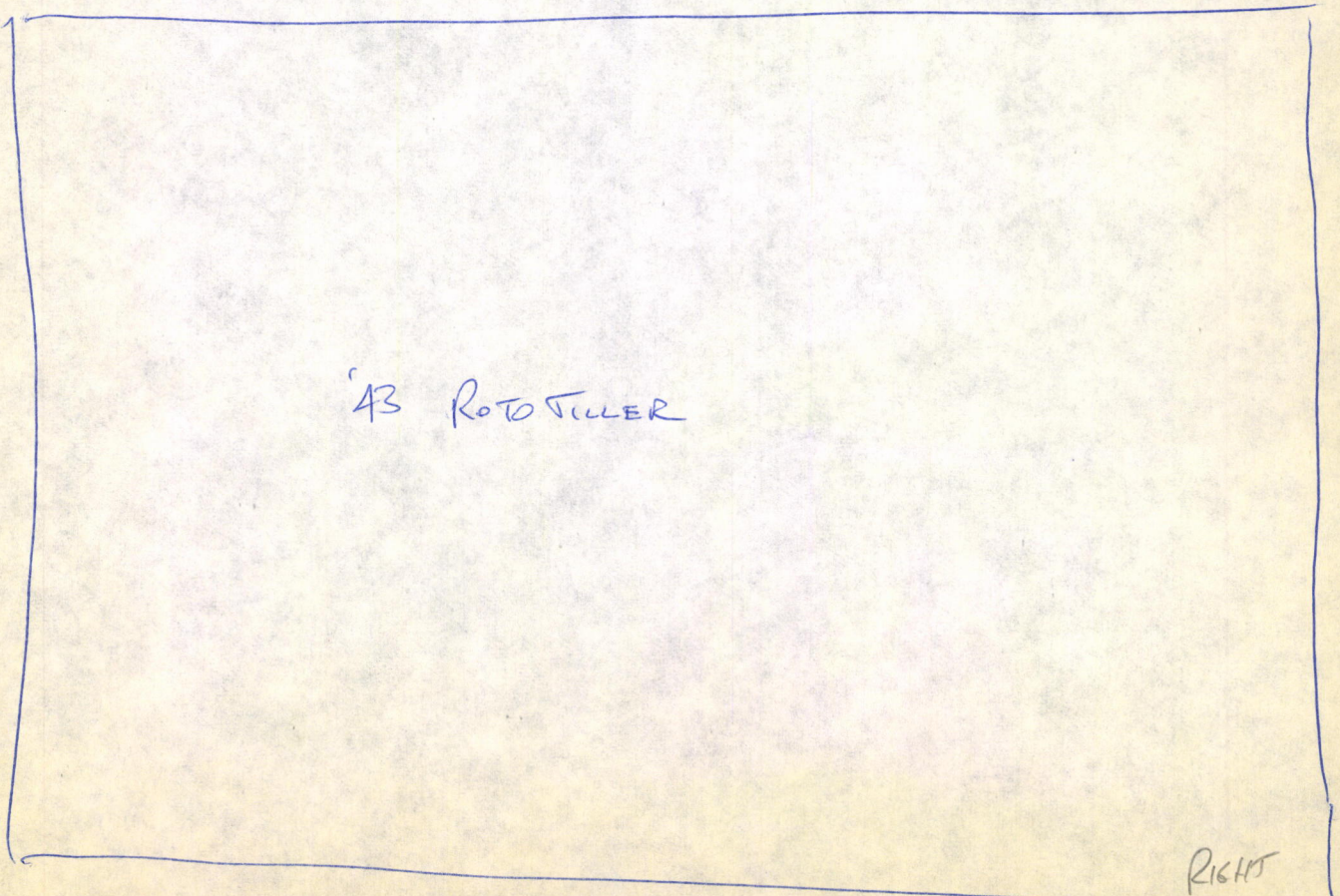
TO LINEAR CYLINDER MEASUREMENTS

2

~~EXHAUST PORTS~~ 2 WORKING SAMPLES

EXHAUST PORT





RIGHT

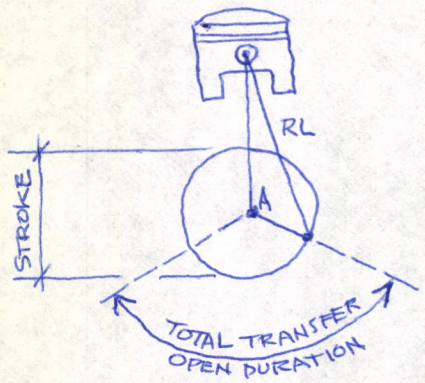
3/4/85

2 CONVERSION FROM ROTATIONAL CRANKSHAFT DEGREES TO LINEAR CYLINDER MEASUREMENTS

TRANSFER PORT | CENTERED WRIST PIN | FOR 2-STROKE CYLINDER TYPES:

PISTON-PORT INTAKE	X
ROTARY-VALVE INTAKE	X
CYLINDER-REED INTAKE	X
CASE-REED INTAKE	X

DISCUSSION – MENTION CAN DO WHICH EVER PORT DESIRED, OR ALL



ANGLE A IS THE DEGREES AFTER TOP DEAD CENTER (OR BEFORE TOP DEAD CENTER) WHEN THE TRANSFER PORT OPENS (CLOSES).

IF ONLY THE TOTAL TRANSFER PORT OPEN DURATION IS KNOWN, DO THIS FIRST; ENTER:

ANGLE A =

360	−	DEGREES OF TOTAL DURATION	=	÷	2	=	ANSWER	DEGREES

GIVEN:

ENGINE YEAR/MANUFACTURE/MODEL

1. STROKE * = ____ MM / INCH
2. ROD LENGTH = ____ MM / INCH
3. ANGLE A = ____ DEGREES ATDC WHEN TRANSFER PORT OPENS
   DEGREES BTDC WHEN TRANSFER PORT CLOSES

TO SOLVE FOR MEASUREMENT FROM TDC TO TOP OF TRANSFER PORT ENTER:

ANGLE A	SIN	X	(	STROKE	÷	2	)	÷	ROD LENGTH	=	.....

INV	SIN	+	ANGLE A	=	+/−	+	180	=	SIN	X	ROD LENGTH	.....

÷	ANGLE A	SIN	=	+/−	+	(	STROKE	÷	2	)	.....

+	ROD LENGTH	=	ANSWER	MM/INCH MEASUREMENT FROM TDC TO TOP OF TRANSFER PORT

3/4/85

2

CONVERSION FROM ROTATIONAL CRANKSHAFT ~~DEGREES~~

TO LINEAR CYLINDER ~~MEASUREMENTS~~

2 WORKING EXAMPLES

TRANSFER PORT

TZ 250 H

43 ROTOTILLER

RIGHT
PAGE 93

3/4/85

2 CONVERSION FROM ROTATIONAL CRANKSHAFT DEGREES TO LINEAR CYLINDER MEASUREMENTS

INTAKE PORT | CENTERED WRISTPIN | FOR 2-STROKE CYLINDER TYPES:

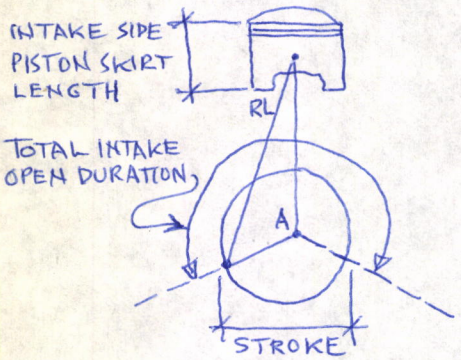
DISCUSSION

DON'T FORGET TO ADD ON (OR SUBT. FROM) TDC-TDC MEAS, DEPENDING UPON CALCS MADE
MENTION FLOW THRU REED TRANSFER &/OR BOOST PORTS

DON'T FORGET ANY OFFSET WRIST PIN CALCS

PISTON-PORT INTAKE	X
ROTARY-VALVE INTAKE	
★ CYLINDER-REED INTAKE	X
CASE-REED INTAKE	

★ WHEN TOTAL OPEN DURATION IS LESS THAN 360°



MEASURE TO BOTTOM OF INTAKE SIDE PISTON SKIRT THAT OPENS THE INTAKE PORT FIRST.

ANGLE A IS THE DEGREES BEFORE TOP DEAD CENTER (OR AFTER TOP DEAD CENTER) WHEN THE INTAKE PORT OPENS (CLOSES).

IF ONLY THE TOTAL INTAKE PORT OPEN DURATION IS KNOWN, DO THIS FIRST; ENTER:

ANGLE A = [DEGREES OF TOTAL DURATION] ÷ 2 = [ANSWER] DEGREES

GIVEN:

ENGINE YEAR/MANUFACTURER/MODEL

1. STROKE = MM/INCH
2. ROD LENGTH = MM/INCH
3. SKIRT LENGTH = MM/INCH
4. ANGLE A = DEGREES BTDC WHEN INTAKE PORT OPENS
   DEGREES ATDC WHEN INTAKE PORT CLOSES

TO SOLVE FOR MEASUREMENT FROM TDC TO BOTTOM OF INTAKE PORT, ENTER:

ANGLE A | SIN | × | (| STROKE | ÷ | 2 |) | ÷ | ROD LENGTH | = ...

INV | SIN | + | ANGLE A | = | +/- | + | 180 | = | SIN | × | ROD LENGTH .....

÷ | ANGLE A | SIN | = | +/- | + | (| STROKE | ÷ | 2 |) | + ...

ROD LENGTH | + | SKIRT LENGTH | = | ANSWER

MM/INCH MEASUREMENT FROM TDC TO BOTTOM OF INTAKE PORT FOR ABOVE PISTON SKIRT LENGTH

LEFT PAGE 94

3/4/85

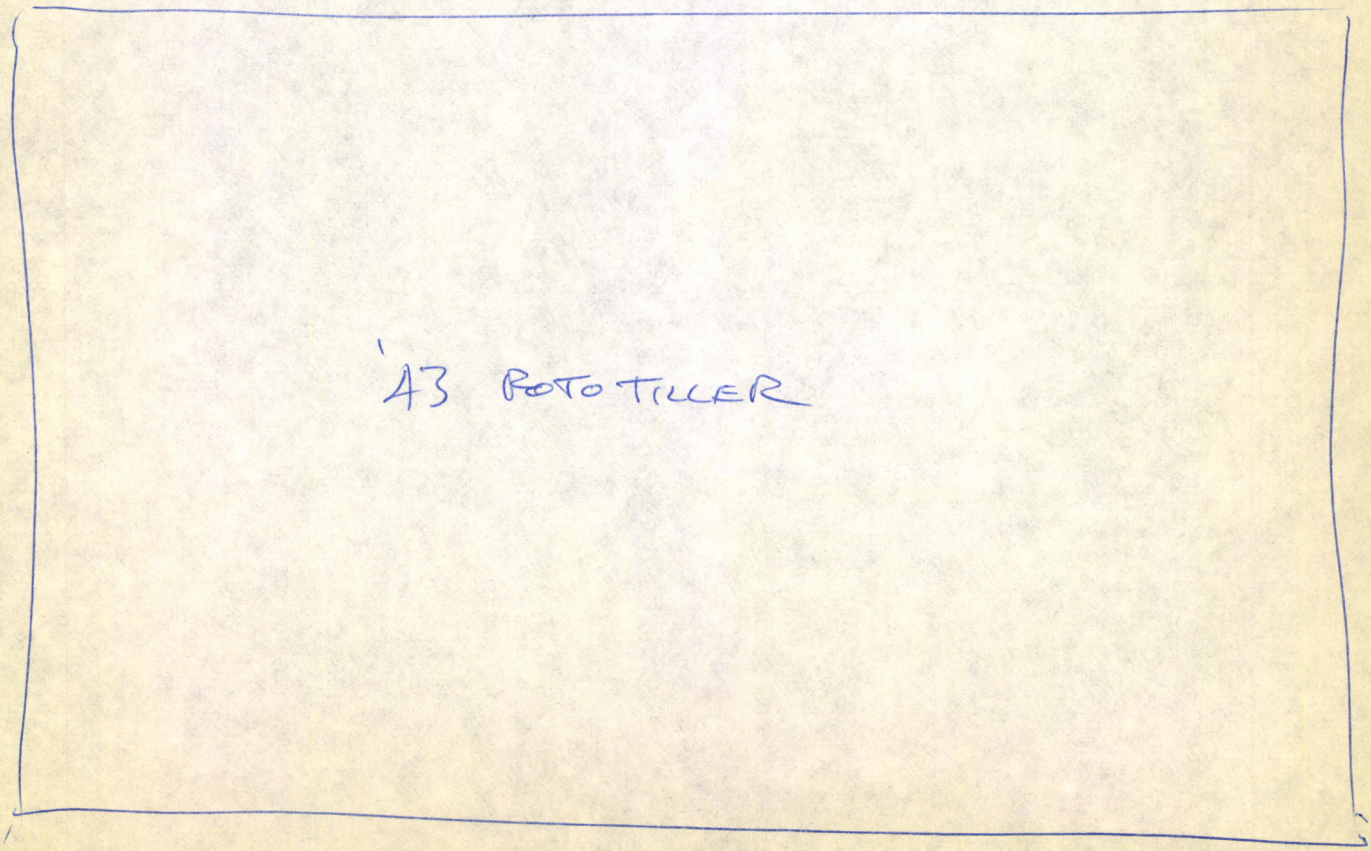
2

CONVERSION FROM ROTATIONAL CRANKSHAFT DEGREES TO LINEAR CYLINDER MEASUREMENTS

2 WORKING EXAMPLES

INTAKE PORT

TZ 250H



RIGHT PAGE 95

LEFT

6/6/84

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTIONAL CRANKSHAFT DEGREES

COMPUTER PRINTOUT WORKSHEET, FILLED IN

DISCUSSION

SEE PAGE ___ FOR A LARGER, BLANK VERSION OF THE FOLLOWING WORKSHEET. IT IS INTENDED FOR SELF-USE. PERMISSION IS HEREBY GRANTED FOR A PHOTOCOPY TO BE MADE, FROM WHICH MANY COPIES CAN THEN BE MADE. THE SALE, FOR ANY PERSONAL OR BUSINESS GAINS, OF ANY REPRODUCED WORKSHEET COPIES, IS NOT PERMITTED HOWEVER.

PISTON-PORT

REDUCED COPY OF MY COMPUTER WORKSHEET, FILLED IN.

'81 YAMAHA TZ250H (OR "L" ?)

H1

RIGHT

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

COMPUTER PRINTOUT WORKSHEET, FILLED IN

DISCUSSION

REDUCED COPY OF MY ROTARY-VALVE COMPUTER WORKSHEET, FILLED IN.

'84 ROTAX 250 "256"

SEE PAGE ___ FOR A LARGER VERSION ---- ETC ----.

(SEE P. 71)

LEFT

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

2-STROKE

COMPUTER PRINTOUT, TYPICAL FOR PISTON-PORT ~~CYLINDER~~

'84 YAMAHA TRZ50L

(CONTINUED ON PAGE 75)

T3

RIGHT

CONVERSION OF LINEAR CYLINDER MEASUREMENTS TO ROTATIONAL CRANKSHAFT DEGREES

COMPUTER PRINTOUT, TYPICAL FOR ROTARY-VALVE 2-STROKE

'84 ~~[redacted]~~
ROTAX 250 "256"

(CONTINUED ON PAGE 76)

LEFT

(CONTINUED FROM PAGE 73)

'84 YAMAHA TZ250H

(CONTINUED ON PAGE 77

(CONTINUED FROM PAGE 74)

RIGHT

'84 ROTAX 250 "256"

(CONTINUED ON PAGE 78)

1981 YAMAHA TZ250H

I. PRINTOUT ORDER:

This Printout is For.....	Pat Calhoun
Name of Business.....	CALHOUN DEVELOPMENT
Street Address, or PO Box Number....	2431 Dolphin Drive
Town, State, Zip Code.....	San Jose, Calif 95124
Phone Number.....	(408)356-0617
Printout Date & REFERENCE Number....	11/11/84 - PP2M-000001

II. GENERAL ENGINE DATA:

ADD — PRIMARY COMPRESSION RATIO ? (PROBABLY)

Engine Serial Number.....	None Given
Engine Cycle/Intake Type.....	2-Stroke/Piston-Port
Engine Configuration.....	180-Degree Parallel Twin
Engine Cooling Method.....	Liquid-Cooled
Bridged Intake/Exhaust Ports.....	No/No
Power-Valved/ATAC Exhaust Port.....	Yes/No
Stock or Modified Engine.....	Standard Production
General Engine Application.....	Motorcycle
Specific Engine Application.....	AMA F-II GP Pavement Racing
Printout Restriction Status.....	None
All Dimensional Input.....	mm & mm-decimal to 1/1,000ths-mm
rpm redline.....	12,000+
maximum hp @ wht rpm.....	by Manual: 54+ @ 11,000
maximum torque @ what rpm.....	by Manual: 26+ lbs/ft @ 10,750
compression ratio.....	by Manual: 7.9:1/12.2-cc in Head
ignition timing.....	1.20-mm BTDC
number of carburetors/Mfr./model....	2: Mikuni VM36SS
main jet type/size or number.....	Mikuni long hex/#390 W/new bike
exhaust system Mfr./model.....	Yamaha/Standard System

III. SPECIFIC ENGINE DATA, GIVEN: (all measurements are average)

Number of Cylinders.....	2		
Bore.....	56	-mm	(2.2047 -In)
Stroke.....	50.7	-mm	(1.9961 -In)
Rod Length, center-to-center.....	105	-mm	(4.1339 -In)
Exhaust Port Width.....	41.25	-mm	
Intake Port Width.....	45.5	-mm	

(TOC: Top of Cylinder)

Distance from TOC to Piston Skirt/Crown Edge at TDC.....	0.25	-mm
Distance from TOC to Top of Exhaust Port.....	23.5	-mm
Distance from TOC to Top of Forward Transfer Port.....	38.5	-mm
Distance from TOC to Top of Middle Transfer Port.....	0	-mm
Distance from TOC to Top of Rear Transfer Port.....	38.5	-mm
Distance from TOC to Bottom of Intake Port.....	88	-mm
Intake Piston Skirt Length, from Skirt Bottom to Skirt Top at Skirt/Crown edge....	53.75	-mm

IV. SPECIFIC ENGINE DATA, CALCULATED:

1) Single Cylinder Displacement.....	124.875	-cc	(7.62 -CuIn)
2) Total Engine Displacement.....	249.75	-cc	(15.24 -CuIn)
3) Bore-to-Stroke Ratio.....	1.1045	:1	
4) Rod Length-to-Stroke Ratio.....	2.071	:1	
5) Peak Piston Speed at All RPM Occurs @.....	76.427	-Degrees BTDC & ATDC	
6) Total Rod Swing Angle Under Wristpin.....	27.146	-Degrees	

(pre-production copy: formulas not hand-checked for accuracy)

V. ENGINE PORTING DATA, CALCULATED:

SHOULD BE INCLUDED FOR ALL PORTS

SHOULD HAVE CHORD WIDTH OF PORTS?

Exhaust Port:

x) TOC TO TOP OF EXHAUST PORT

7)	TDC to Top of Exhaust Port.....	23.25	-mm
8)	Exhaust Port opens at.....	78.441	-Degrees ATDC
9)	Total Exhaust Port Open Duration is.....	203.118	-Degrees

Forward Transfer Ports:

10)	TDC to Top of Forward Transfer Ports.....	38.25	-mm
11)	Forword Transfer Ports open at.....	114.01	-Degrees ATDC
12)	Total Forward Transfer Port Open Duration is....	131.98	-Degrees

Middle Transfer Ports:

13)	TDC to Top of Middle Transfer Ports.....	0	-mm
14)	Middle Transfer Ports open at.....	0	-Degrees ATDC
15)	Total Middle Transfer Port Open Duration is.....	0	-Degrees

Rear Transfer Ports:

16)	TDC to Top of Rear Transfer Ports.....	38.25	-mm
17)	Rear Transfer Ports open at.....	114.01	-Degrees ATDC
18)	Total Rear Transfer Port Open Duration is.....	131.98	-Degrees

Intake Port:

19)	TDC to Bottom of Intake Port.....	87.75	-mm
20)	Intake Port opens at.....	103.002	-Degrees BTDC
21)	Total Intake Port Open Duration is.....	206.004	-Degrees

Port Width Percentages of Bore:

22)	Exhaust Port Width as Percentage of Bore.....	73.66	-%
23)	Intake Port Width as Percentage of Bore.....	81.25	-%

Port Open Degrees-Duration Percentages:

24)	Total Exhaust Open Degrees-Duration % Constant.....	100.00	-%
25)	Forward Transfer Open Duration as % of Exhaust.....	64.98	-%
26)	Middle Transfer Open Duration as % of Exhaust.....	0	-%
27)	Rear Transfer Open Duration as % of Exhaust.....	64.98	-%
28)	Intake Open Duration as % of Exhaust.....	101.42	-%

Peak Piston Speed and Port Phasing Degrees:

The point at which the Peak Piston Speed occurs, ITEM 5), is generally considered to be the exhaust port's absolute Maximum Opening Degrees for ANY possible purpose;

PRACTICAL

29)	TDC to Exhaust Port @ above Maximum Opening Degrees...	22.33	-mm

Exhaust, Transfer, and Intake Port Phasings:

30)	Degrees Exhaust Port Opens after Peak Piston Speed....	2.01	-Degrees
31)	Blowdown: Highest Transfer Opens after Exhaust Opens..	35.569	-Degrees
32)	Intake Port Opens after Highest Transfer Closes.....	11.008	-Degrees

VI. PORT-HEIGHT VARIATIONS TABLE:

Since port dimensions vary between cylinders, the table below gives various port height information; ports outside the table range can be graphed based on the table data; 1st No. is vertical dimension from TDC/ 2nd is when port opens/ 3rd is duration:

33) TDC to top of EXHAUST	34) TDC to top of TRANSFER	35) TDC to INTAKE bottom & PISTON SKIRT LENGTH combination
23.6 -mm/ 79.21 -deg ATDC/ 201.58 -deg	38.6 -mm/ 114.98 -deg ATDC/ 130.04 -deg	87.2 -mm/ 101.66 -deg BTDC/ 203.32 -deg
23.5 -mm/ 78.99 -deg ATDC/ 202.02 -deg	38.5 -mm/ 114.7 -deg ATDC/ 130.6 -deg	87.4 -mm/ 102.15 -deg BTDC/ 204.3 -deg
23.4 -mm/ 78.77 -deg ATDC/ 202.46 -deg	38.4 -mm/ 114.42 -deg ATDC/ 131.16 -deg	87.6 -mm/ 102.63 -deg BTDC/ 205.26 -deg
23.3 -mm/ 78.55 -deg ATDC/ 202.9 -deg	38.3 -mm/ 114.15 -deg ATDC/ 131.7 -deg	87.8 -mm/ 103.13 -deg BTDC/ 206.26 -deg
23.2 -mm/ 78.33 -deg ATDC/ 203.34 -deg	38.2 -mm/ 113.87 -deg ATDC/ 132.26 -deg	88 -mm/ 103.62 -deg BTDC/ 207.24 -deg
23.1 -mm/ 78.11 -deg ATDC/ 203.78 -deg	38.1 -mm/ 113.6 -deg ATDC/ 132.8 -deg	88.2 -mm/ 104.11 -deg BTDC/ 208.22 -deg
23 -mm/ 77.89 -deg ATDC/ 204.22 -deg	38 -mm/ 113.32 -deg ATDC/ 133.36 -deg	88.4 -mm/ 104.61 -deg BTDC/ 209.22 -deg
22.9 -mm/ 77.67 -deg ATDC/ 204.66 -deg	37.9 -mm/ 113.05 -deg ATDC/ 133.9 -deg	88.6 -mm/ 105.11 -deg BTDC/ 210.22 -deg
22.8 -mm/ 77.45 -deg ATDC/ 205.1 -deg	37.8 -mm/ 112.78 -deg ATDC/ 134.44 -deg	88.8 -mm/ 105.61 -deg BTDC/ 211.22 -deg
22.7 -mm/ 77.23 -deg ATDC/ 205.54 -deg	37.7 -mm/ 112.51 -deg ATDC/ 134.98 -deg	89 -mm/ 106.12 -deg BTDC/ 212.24 -deg

VII. COMPRESSION RATIO TABLE: (based on Section III Data)

(36) COMPRESSION RATIO	(37) TRAPPED CYLINDER HEAD VOLUME AT TDC: CC's	(38) COMPRESSION RATIO	(39) TRAPPED CYLINDER HEAD VOLUME AT TDC: CC's	(40) COMPRESSION RATIO	(41) TRAPPED CYLINDER HEAD VOLUME AT TDC: CC's
5.5 :1	= 12.73	7 :1	= 9.54	8.5 :1	= 7.64
5.525 :1	= 12.66	7.025 :1	= 9.5	8.525 :1	= 7.61
5.55 :1	= 12.59	7.05 :1	= 9.47	8.55 :1	= 7.58
5.575 :1	= 12.52	7.075 :1	= 9.43	8.575 :1	= 7.56
5.6 :1	= 12.45	7.1 :1	= 9.39	8.6 :1	= 7.53
5.625 :1	= 12.38	7.125 :1	= 9.35	8.625 :1	= 7.51
5.65 :1	= 12.32	7.15 :1	= 9.31	8.65 :1	= 7.49
5.675 :1	= 12.25	7.175 :1	= 9.27	8.675 :1	= 7.46
5.7 :1	= 12.18	7.2 :1	= 9.24	8.7 :1	= 7.44
5.725 :1	= 12.12	7.225 :1	= 9.2	8.725 :1	= 7.41
5.75 :1	= 12.06	7.25 :1	= 9.16	8.75 :1	= 7.39
5.775 :1	= 11.99	7.275 :1	= 9.13	8.775 :1	= 7.37
5.8 :1	= 11.93	7.3 :1	= 9.09	8.8 :1	= 7.34
5.825 :1	= 11.87	7.325 :1	= 9.05	8.825 :1	= 7.32
5.85 :1	= 11.81	7.35 :1	= 9.02	8.85 :1	= 7.29
5.875 :1	= 11.75	7.375 :1	= 8.98	8.875 :1	= 7.27
5.9 :1	= 11.69	7.4 :1	= 8.95	8.9 :1	= 7.25
5.925 :1	= 11.63	7.425 :1	= 8.91	8.925 :1	= 7.23
5.95 :1	= 11.57	7.45 :1	= 8.88	8.95 :1	= 7.2
5.975 :1	= 11.51	7.475 :1	= 8.84	8.975 :1	= 7.18
6 :1	= 11.45	7.5 :1	= 8.81	9 :1	= 7.16
6.025 :1	= 11.4	7.525 :1	= 8.78	9.025 :1	= 7.14
6.05 :1	= 11.34	7.55 :1	= 8.74	9.05 :1	= 7.11
6.075 :1	= 11.28	7.575 :1	= 8.71	9.075 :1	= 7.09
6.1 :1	= 11.23	7.6 :1	= 8.68	9.1 :1	= 7.07
6.125 :1	= 11.17	7.625 :1	= 8.64	9.125 :1	= 7.05
6.15 :1	= 11.12	7.65 :1	= 8.61	9.15 :1	= 7.03
6.175 :1	= 11.07	7.675 :1	= 8.58	9.175 :1	= 7
6.2 :1	= 11.01	7.7 :1	= 8.55	9.2 :1	= 6.98
6.225 :1	= 10.96	7.725 :1	= 8.52	9.225 :1	= 6.96
6.25 :1	= 10.91	7.75 :1	= 8.48	9.25 :1	= 6.94
6.275 :1	= 10.86	7.775 :1	= 8.45	9.275 :1	= 6.92
6.3 :1	= 10.8	7.8 :1	= 8.42	9.3 :1	= 6.9
6.325 :1	= 10.75	7.825 :1	= 8.39	9.325 :1	= 6.88
6.35 :1	= 10.7	7.85 :1	= 8.36	9.35 :1	= 6.86
6.375 :1	= 10.65	7.875 :1	= 8.33	9.375 :1	= 6.84
6.4 :1	= 10.6	7.9 :1	= 8.3	9.4 :1	= 6.82
6.425 :1	= 10.56	7.925 :1	= 8.27	9.425 :1	= 6.8
6.45 :1	= 10.51	7.95 :1	= 8.24	9.45 :1	= 6.78
6.475 :1	= 10.46	7.975 :1	= 8.21	9.475 :1	= 6.76
6.5 :1	= 10.41	8 :1	= 8.18	9.5 :1	= 6.74
6.525 :1	= 10.36	8.025 :1	= 8.15	9.525 :1	= 6.72
6.55 :1	= 10.32	8.05 :1	= 8.12	9.55 :1	= 6.7
6.575 :1	= 10.27	8.075 :1	= 8.09	9.575 :1	= 6.68
6.6 :1	= 10.23	8.1 :1	= 8.07	9.6 :1	= 6.66
6.625 :1	= 10.18	8.125 :1	= 8.04	9.625 :1	= 6.64
6.65 :1	= 10.14	8.15 :1	= 8.01	9.65 :1	= 6.62
6.675 :1	= 10.09	8.175 :1	= 7.98	9.675 :1	= 6.6
6.7 :1	= 10.05	8.2 :1	= 7.95	9.7 :1	= 6.58
6.725 :1	= 10	8.225 :1	= 7.93	9.725 :1	= 6.56
6.75 :1	= 9.96	8.25 :1	= 7.9	9.75 :1	= 6.54
6.775 :1	= 9.92	8.275 :1	= 7.87	9.775 :1	= 6.53
6.8 :1	= 9.87	8.3 :1	= 7.84	9.8 :1	= 6.51
6.825 :1	= 9.83	8.325 :1	= 7.82	9.825 :1	= 6.49
6.85 :1	= 9.79	8.35 :1	= 7.79	9.85 :1	= 6.47
6.875 :1	= 9.75	8.375 :1	= 7.76	9.875 :1	= 6.45
6.9 :1	= 9.71	8.4 :1	= 7.74	9.9 :1	= 6.43
6.925 :1	= 9.66	8.425 :1	= 7.71	9.925 :1	= 6.42
6.95 :1	= 9.62	8.45 :1	= 7.69	9.95 :1	= 6.4
6.975 :1	= 9.58	8.475 :1	= 7.66	9.975 :1	= 6.38

VIII. RPM, PISTON SPEED and ACCELERATION, CRANK ROTATION TIME-PERIOD TABLE:

(42) CRANKSHAFT RPM	(43) MEAN PISTON SPEED: Ft/Min	(44) PEAK PISTON SPEED: Ft/Min	(45) MAXIMUM PISTON ACCEL-ERATION: Ft/Sec-Sec	(46) ROD BIG-END LINEAR-SPEED AROUND STROKE CIRCLE: Ft/Min	(47) TIME-PERIOD FOR 1-DEGREE OF CRANKSHAFT ROTATION: Seconds
8000	2661	4321	72468	4181	.00002083
8100	2695	4373	74291	4233	.00002058
8200	2728	4427	76136	4285	.00002033
8300	2761	4482	78005	4337	.00002008
8400	2794	4536	79896	4390	.00001984
8500	2828	4589	81809	4442	.00001961
8600	2861	4644	83745	4494	.00001938
8700	2894	4697	85704	4546	.00001916
8800	2928	4752	87686	4599	.00001894
8900	2961	4805	89690	4651	.00001873
9000	2994	4860	91717	4703	.00001852
9100	3027	4913	93766	4755	.00001832
9200	3061	4967	95838	4808	.00001812
9300	3094	5022	97933	4860	.00001792
9400	3127	5076	100051	4912	.00001773
9500	3160	5131	102191	4964	.00001754
9600	3194	5184	104353	5017	.00001736
9700	3227	5239	106539	5069	.00001718
9800	3260	5291	108747	5121	.00001701
9900	3294	5344	110977	5173	.00001684
10000	3327	5399	113231	5226	.00001667
10100	3360	5455	115507	5278	.0000165
10200	3393	5508	117805	5330	.00001634
10300	3427	5562	120126	5382	.00001618
10400	3460	5614	122470	5435	.00001603
10500	3493	5671	124837	5487	.00001587
10600	3526	5725	127226	5539	.00001572
10700	3560	5777	129638	5591	.00001558
10800	3593	5833	132072	5644	.00001543
10900	3626	5886	134529	5696	.00001529
11000	3659	5941	137009	5748	.00001515
11100	3693	5992	139512	5801	.00001502
11200	3726	6048	142037	5853	.00001488
11300	3759	6102	144584	5905	.00001475
11400	3793	6156	147155	5957	.00001462
11500	3826	6211	149748	6010	.00001449
11600	3859	6263	152363	6062	.00001437
11700	3892	6316	155002	6114	.00001425
11800	3926	6374	157662	6166	.00001412
11900	3959	6424	160346	6219	.00001401
12000	3992	6479	163052	6271	.00001389
12100	4025	6536	165781	6323	.00001377
12200	4059	6589	168533	6375	.00001366
12300	4092	6642	171307	6428	.00001355
12400	4125	6696	174104	6480	.00001344
12500	4158	6752	176923	6532	.00001333
12600	4192	6803	179765	6584	.00001323
12700	4225	6860	182630	6637	.00001312
12800	4258	6912	185517	6689	.00001302
12900	4292	6966	188427	6741	.00001292
13000	4325	7020	191360	6793	.00001282
13100	4358	7075	194315	6846	.00001272
13200	4391	7126	197293	6898	.00001263
13300	4425	7183	200294	6950	.00001253
13400	4458	7235	203317	7002	.00001244
13500	4491	7287	206363	7055	.00001235

NOTE: To find a TIME-factor, in seconds, for any desired degree spread of crankshaft rotation, for any desired RPM: select a TIME-PERIOD (Col. 47), which corresponds to the desired RPM (Col. 42), & multiply that TIME-PERIOD by the desired degree spread of crankshaft rotation.
EXAMPLE: 196-degrees @ 11000-rpm: (.00001515 --from Col. 47 for 11000-rpm) (196-degrees) = .0029792-seconds

IX. CRANKSHAFT DEGREES, PISTON TRAVEL, CYLINDER CFM and DISPLACEMENT TABLE, TDC to 60-Degrees:

(48) CRANKSHAFT ROTATION FROM TDC: Degrees	(49) PISTON TRAVEL FROM TDC: Millimeters	(50) Inches	(51) SINGLE CYLINDER CFM @ 1-RPM	(52) SINGLE CYLINDER DISPLACEMENT FROM TDC: Percent
1	.005	.0002	4.3E-7	.01
2	.019	.0007	1.65E-6	.037
3	.043	.0017	3.74E-6	.085
4	.077	.003	6.7E-6	0.152
5	0.12	.0047	.00001044	0.237
6	0.172	.0068	.00001496	0.339
7	0.234	.0092	.00002035	0.462
8	0.306	.012	.00002662	0.604
9	0.387	.0152	.00003366	0.763
10	0.477	.0188	.00004149	0.941
11	0.577	.0227	.00005019	1.138
12	0.686	.027	.00005967	1.353
13	0.805	.0317	.00007002	1.588
14	0.932	.0367	.00008107	1.838
15	1.069	.0421	.00009298	2.108
16	1.215	.0478	.00010568	2.396
17	1.37	.0539	.00011916	2.702
18	1.533	.0604	.00013334	3.024
19	1.706	.0672	.00014839	3.365
20	1.887	.0743	.00016413	3.722
21	2.077	.0818	.00018066	4.097
22	2.276	.0896	.00019797	4.489
23	2.483	.0978	.00021597	4.897
24	2.699	0.1063	.00023476	5.323
25	2.923	0.1151	.00025425	5.765
26	3.155	0.1242	.00027443	6.223
27	3.396	0.1337	.00029539	6.698
28	3.644	0.1435	.00031696	7.187
29	3.9	0.1535	.00033923	7.692
30	4.164	0.1639	.00036219	8.213
31	4.436	0.1746	.00038585	8.75
32	4.715	0.1856	.00041012	9.3
33	5.001	0.1969	.00043499	9.864
34	5.295	0.2085	.00046057	10.444
35	5.596	0.2203	.00048675	11.037
36	5.904	0.2324	.00051354	11.645
37	6.219	0.2448	.00054094	12.266
38	6.54	0.2575	.00056886	12.899
39	6.868	0.2704	.00059739	13.546
40	7.203	0.2836	.00062653	14.207
41	7.544	0.297	.00065619	14.88
42	7.89	0.3106	.00068628	15.562
43	8.243	0.3245	.00071699	16.258
44	8.602	0.3387	.00074821	16.966
45	8.966	0.353	.00077987	17.684
46	9.336	0.3676	.00081206	18.414
47	9.711	0.3823	.00084468	19.154
48	10.091	0.3973	.00087773	19.903
49	10.477	0.4125	.0009113	20.665
50	10.867	0.4278	.00094523	21.434
51	11.261	0.4433	.0009795	22.211
52	11.661	0.4591	.00101429	23
53	12.064	0.475	.00104934	23.795
54	12.472	0.491	.00108483	24.6
55	12.884	0.5072	.00112067	25.412
56	13.299	0.5236	.00115677	26.231
57	13.718	0.5401	.00119321	27.057
58	14.141	0.5567	.00123	27.892
59	14.567	0.5735	.00126706	28.732
60	14.996	0.5904	.00130437	29.578

NOTE: To find a Cylinder's Displacement, in CFM: select SINGLE CYLINDER CFM @ 1-RPM, which corresponds with the CRANKSHAFT ROTATION or PISTON TRAVEL wanted, and multiply that CFM by the desired RPM, or:
-- (SINGLE CYLINDER CFM @ 1-RPM) (any desired RPM) = Single Cylinder CFM .....(CFM) (1728) = CuIn/Min

IX. CRANKSHAFT DEGREES, PISTON TRAVEL, CYLINDER CFM and DISPLACEMENT TABLE, 61 to 120-Degrees:

(53) CRANKSHAFT ROTATION FROM TDC: Degrees	(54) PISTON TRAVEL FROM TDC: Millimeters	(55) Inches	(56) SINGLE CYLINDER CFM @ 1-RPM	(57) SINGLE CYLINDER DISPLACEMENT FROM TDC: Percent
61	15.428	0.6074	.00134195	30.43
62	15.862	0.6245	.0013797	31.286
63	16.3	0.6417	.0014178	32.15
64	16.739	0.659	.00145598	33.016
65	17.181	0.6764	.00149443	33.888
66	17.625	0.6939	.00153305	34.763
67	18.071	0.7115	.00157184	35.643
68	18.518	0.7291	.00161072	36.525
69	18.967	0.7467	.00164978	37.41
70	19.418	0.7645	.001689	38.3
71	19.869	0.7822	.00172823	39.189
72	20.322	0.8001	.00176764	40.083
73	20.775	0.8179	.00180704	40.976
74	21.229	0.8358	.00184653	41.872
75	21.684	0.8537	.0018861	42.769
76	22.139	0.8716	.00192568	43.667
77	22.594	0.8895	.00196526	44.564
78	23.049	0.9074	.00200483	45.462
79	23.504	0.9254	.00204441	46.359
80	23.959	0.9433	.00208399	47.256
81	24.413	0.9611	.00212348	48.152
82	24.867	0.979	.00216297	49.047
83	25.32	0.9969	.00220237	49.941
84	25.772	1.0146	.00224168	50.832
85	26.223	1.0324	.00228091	51.722
86	26.672	1.0501	.00231997	52.607
87	27.121	1.0678	.00235902	53.493
88	27.568	1.0854	.0023979	54.375
89	28.013	1.1029	.00243661	55.252
90	28.456	1.1203	.00247514	56.126
91	28.898	1.1377	.00251359	56.998
92	29.337	1.155	.00255177	57.864
93	29.774	1.1722	.00258978	58.726
94	30.209	1.1893	.00262762	59.584
95	30.641	1.2063	.0026652	60.436
96	31.071	1.2233	.0027026	61.284
97	31.499	1.2401	.00273983	62.128
98	31.923	1.2568	.00277671	62.964
99	32.345	1.2734	.00281341	63.797
100	32.763	1.2899	.00284977	64.621
101	33.178	1.3062	.00288587	65.44
102	33.59	1.3224	.0029217	66.252
103	33.999	1.3385	.00295728	67.059
104	34.404	1.3545	.00299251	67.858
105	34.806	1.3703	.00302747	68.651
106	35.204	1.386	.00306209	69.436
107	35.598	1.4015	.00309636	70.213
108	35.989	1.4169	.00313037	70.984
109	36.376	1.4321	.00316403	71.748
110	36.758	1.4472	.00319726	72.501
111	37.136	1.462	.00323014	73.247
112	37.511	1.4768	.00326276	73.986
113	37.881	1.4914	.00329494	74.716
114	38.246	1.5057	.00332669	75.436
115	38.608	1.52	.00335818	76.15
116	38.965	1.5341	.00338923	76.854
117	39.317	1.5479	.00341985	77.548
118	39.664	1.5616	.00345003	78.233
119	40.007	1.5751	.00347986	78.909
120	40.346	1.5884	.00350935	79.578

NOTE: To find a Cylinder's Displacement, in CFM: select SINGLE CYLINDER CFM @ 1-RPM, which corresponds with the CRANKSHAFT ROTATION or PISTON TRAVEL wanted, and multiply that CFM by the desired RPM, or:
-- (SINGLE CYLINDER CFM @ 1-RPM) (any desired RPM) = Single Cylinder CFM .....(CFM) (1728) = CuIn/Min

IX. CRANKSHAFT DEGREES, PISTON TRAVEL, CYLINDER CFM and DISPLACEMENT TABLE, 121 to 180-Degrees:

(58) CRANKSHAFT ROTATION FROM TDC: Degrees	(59) PISTON TRAVEL FROM TDC: Millimeters	(60) Inches	(61) SINGLE CYLINDER CFM @ 1-RPM	(62) SINGLE CYLINDER DISPLACEMENT FROM TDC: Percent
121	40.679	1.6015	.00353831	80.235
122	41.008	1.6145	.00356693	80.884
123	41.332	1.6272	.00359511	81.523
124	41.65	1.6398	.00362277	82.15
125	41.964	1.6521	.00365009	82.769
126	42.273	1.6643	.00367696	83.379
127	42.576	1.6762	.00370332	83.976
128	42.875	1.688	.00372933	84.566
129	43.168	1.6995	.00375481	85.144
130	43.456	1.7109	.00377986	85.712
131	43.739	1.722	.00380448	86.27
132	44.016	1.7329	.00382857	86.817
133	44.288	1.7436	.00385223	87.353
134	44.555	1.7541	.00387545	87.88
135	44.817	1.7644	.00389824	88.396
136	45.072	1.7745	.00392042	88.899
137	45.323	1.7844	.00394226	89.394
138	45.568	1.794	.00396357	89.878
139	45.807	1.8034	.00398435	90.349
140	46.041	1.8126	.00400471	90.811
141	46.27	1.8217	.00402463	91.262
142	46.492	1.8304	.00404394	91.7
143	46.71	1.839	.0040629	92.13
144	46.921	1.8473	.00408125	92.546
145	47.127	1.8554	.00409917	92.953
146	47.327	1.8633	.00411657	93.347
147	47.522	1.8709	.00413353	93.732
148	47.711	1.8784	.00414997	94.105
149	47.894	1.8856	.00416588	94.465
150	48.072	1.8926	.00418137	94.817
151	48.243	1.8993	.00419624	95.154
152	48.409	1.9059	.00421068	95.481
153	48.57	1.9122	.00422468	95.799
154	48.724	1.9183	.00423808	96.103
155	48.873	1.9241	.00425104	96.396
156	49.016	1.9298	.00426348	96.679
157	49.153	1.9352	.00427539	96.949
158	49.284	1.9403	.00428679	97.207
159	49.41	1.9453	.00429775	97.456
160	49.53	1.95	.00430819	97.692
161	49.644	1.9545	.0043181	97.917
162	49.752	1.9587	.0043275	98.13
163	49.854	1.9628	.00433637	98.331
164	49.951	1.9666	.00434481	98.523
165	50.041	1.9701	.00435263	98.7
166	50.126	1.9735	.00436003	98.868
167	50.205	1.9766	.0043669	99.024
168	50.278	1.9794	.00437325	99.168
169	50.346	1.9821	.00437916	99.302
170	50.407	1.9845	.00438447	99.422
171	50.463	1.9867	.00438934	99.533
172	50.513	1.9887	.00439369	99.631
173	50.557	1.9904	.00439752	99.718
174	50.595	1.9919	.00440082	99.793
175	50.627	1.9932	.0044036	99.856
176	50.653	1.9942	.00440587	99.907
177	50.674	1.995	.00440769	99.949
178	50.688	1.9956	.00440891	99.976
179	50.697	1.9959	.00440969	99.994
180	50.7	1.9961	.00440995	100

NOTE: To find a Cylinder's Displacement, in CFM: select SINGLE CYLINDER CFM @ 1-RPM, which corresponds with the CRANKSHAFT ROTATION or PISTON TRAVEL wanted, and multiply that CFM by the desired RPM, or:
-- (SINGLE CYLINDER CFM @ 1-RPM) (any desired RPM) = Single Cylinder CFM .....(CFM) (1728) = CuIn/Min

P. 95 4 STROKE SECTION

LEFT HALF

5/29/84

C

DISCUSSION OF
CAM LIFT & DURATION,
AND PISTON SPEED

3/20/85

THIS 4-STROKE
SECTION NEEDS
MUCH WORK.

5/29/84

RIGHT HALF
&
LEFT HALF

P. 96

97

4 STROKE SECTION

DISCUSSION OF DEG WHEEL
& DIAL INDICATOR WORK
& WORKING WITH 720°
WORK SHEET

P. (98) 4 STROKE SECTION

5/29/84

~~RIGHT~~ HALF

BLANK WORK SHEET
FOR CAM LIFT @ 10° INTERVALS
FOR 720°

P. (99) OF 4-STROKE SECTION

5/29/84

HALF LEFT

FILLED IN WORKSHEET FOR 901 Z1 KAW

P. (100) 4-STROKE SECTION

(RIGHT SIDE)

5/29/84

FILLED IN WORKSHEET FOR '84 NINJA

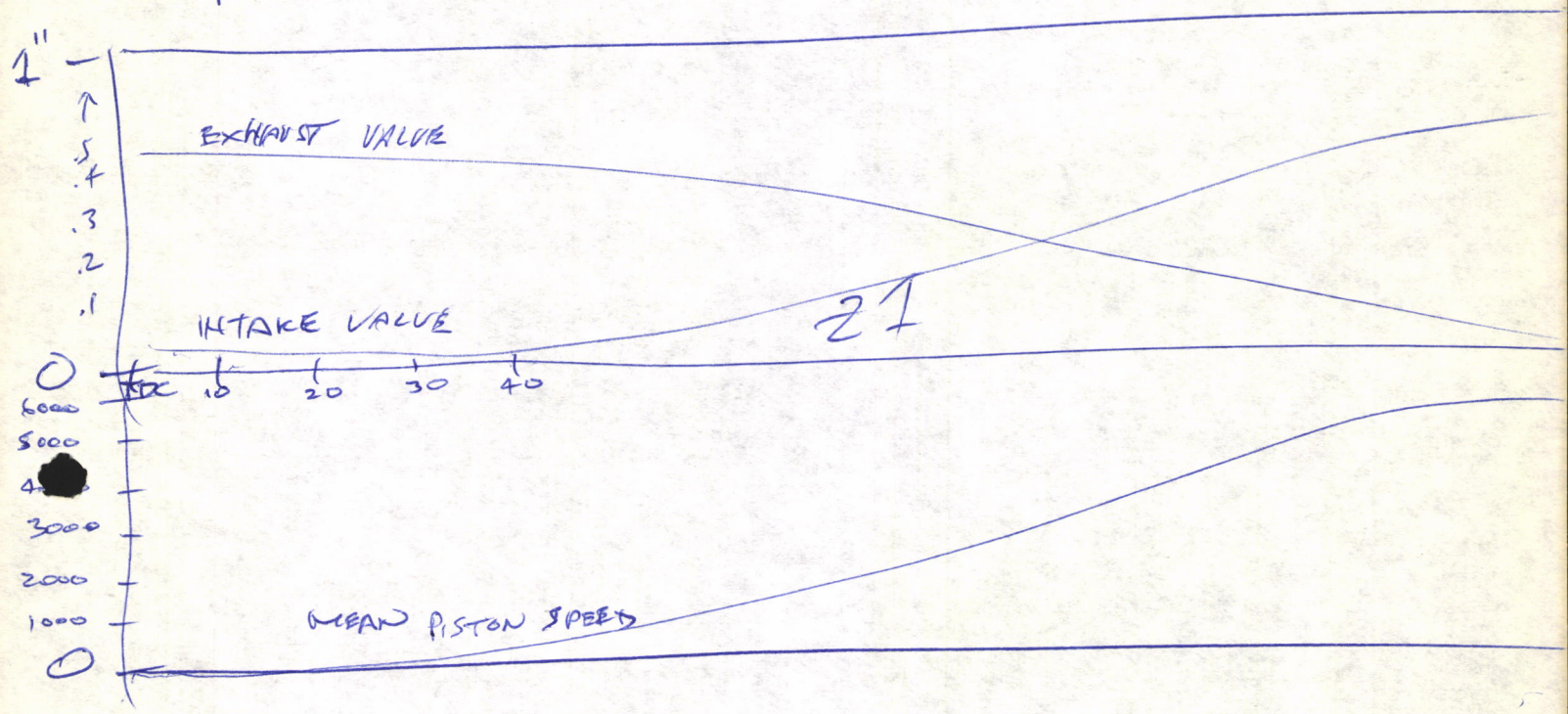
5/29/84

P. 101
102
103
104

4 STROKE SECT

LEFT HALF
RIGHT HALF
LEFT HALF
RIGHT HALF

PRINTOUTS



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Phone Number.....	(415)524-2485
Printout Date & REFERENCE Number..	1/21/85 - FSMM-000002

II. GENERAL (non-input) ENGINE DATA

Engine Serial Number.....	None Given
Engine Cycle.....	4-Stroke
Engine Configuration.....	In-Line 4
General Engine Application.....	Automotive
Specific Engine Application.....	Formula Atlantic (WCAR)
Stock or Modified Engine.....	Standard Ass'y from Cosworth (w/kit)
Engine Cooling Method.....	Water-Cooled
Cam Configuration.....	DOHC (belt driven)
Valve Configuration & Valves/Cyl..	OHV (4/Cylinder)
Crankshaft Main Bearing Type.....	Plain
Con-Rod Big-End Bearing Type.....	Plain
Printout Restriction Status.....	None
All Dimensional Input.....	mm & mm-decimal to 1/1,000ths-mm
rpm redline.....	10,200 (10,500 maximum)
maximum hp @ what rpm.....	220 @ 9,500
maximum torque @ what rpm.....	131-lbs/ft @ 8,000
compression ratio.....	13.1 to 13.5+:1
ignition timing.....	29 to 31-degrees BTDC
number of carburetors/Mfr./model..	4/Weber/50 DCO Down-Draft
valve size: intake/exhaust.....	1.220"/1.000"
valve timing begins at what lift..	@ std valve clnce: I=0.010"/E=0.013"
intake open/closing degrees.....	58-degrees BTDC/82-ABDC
intake full lift/total duration...	0.400"/320-degrees
exhaust open/closing degrees.....	82-degrees BBDC/58-degrees ATDC
exhaust full lift/total duration..	0.037"/320-degrees (slightly less)
overlap degrees.....	116-degrees
cam lobe centerline: Int/Exh.....	102-degrees ATDC/102-degrees BTDC

III. SPECIFIC ENGINE DATA, GIVEN

1) Number of Cylinders.....	4			
2) Bore.....	80	-mm	(3.1496	-In)
3) Stroke.....	77.7	-mm	(3.0591	-In)
4) Rod Length, center-to-center.....	132.791	-mm	(5.228	-In)

IV. SPECIFIC ENGINE DATA, CALCULATED

5) Single Cylinder Displacement.....	390.564	-cc	(23.834	-CuIn)
6) Total Engine Displacement.....	1562.256	-cc	(95.336	-CuIn)
7) Bore-to-Stroke Ratio.....	1.0296	:1		
8) Rod Length-to-Stroke Ratio.....	1.709	:1		
9) Peak Piston Speed at All RPM Occurs @..	73.692	-Degrees BTDC & ATDC		
10) Total Rod Swing Angle Under Wristpin...	32.616	-Degrees		

V. CRANKSHAFT DEGREES, PISTON TRAVEL, and CYLINDER DISPLACEMENT TABLE, TDC to 60-Degrees

(11)	(12)		(13)		(14)		(15)		(16)
CRANKSHAFT ROTATION FROM TDC:	PISTON TRAVEL FROM TDC:				SINGLE CYLINDER DISPLACEMENT FROM TDC:				
Degrees	Millimeters		Inches		CC's		CuIn		Percent
1	.007		.0003		.035		.002		.01
2	.03		.0012		0.151		.009		.039
3	.068		.0027		0.342		.021		.088
4	0.122		.0048		0.613		.037		0.157
5	0.191		.0075		0.96		.058		0.245
6	0.274		.0108		1.377		.084		0.353
7	0.374		.0147		1.88		0.115		0.481
8	0.488		.0192		2.453		0.15		0.628
9	0.617		.0243		3.101		0.189		0.794
10	0.761		.03		3.825		0.234		0.981
11	0.92		.0363		4.624		0.283		1.187
12	1.094		.0431		5.499		0.336		1.409
13	1.283		.0505		6.449		0.393		1.651
14	1.487		.0585		7.474		0.456		1.912
15	1.705		.0671		8.57		0.523		2.193
16	1.937		.0763		9.736		0.594		2.494
17	2.184		.086		10.978		0.67		2.811
18	2.445		.0963		12.29		0.75		3.148
19	2.72		0.1071		13.672		0.834		3.501
20	3.009		0.1185		15.125		0.923		3.874
21	3.312		0.1304		16.648		1.016		4.263
22	3.628		0.1429		18.236		1.113		4.671
23	3.958		0.1559		19.895		1.215		5.096
24	4.302		0.1694		21.624		1.32		5.538
25	4.658		0.1834		23.414		1.429		5.995
26	5.028		0.198		25.274		1.543		6.472
27	5.411		0.213		27.199		1.66		6.963
28	5.806		0.2286		29.184		1.781		7.473
29	6.213		0.2446		31.23		1.906		7.996
30	6.633		0.2612		33.341		2.035		8.538
31	7.065		0.2782		35.513		2.167		9.094
32	7.509		0.2956		37.744		2.303		9.663
33	7.964		0.3136		40.032		2.443		10.251
34	8.431		0.3319		42.379		2.586		10.85
35	8.909		0.3508		44.782		2.733		11.467
36	9.398		0.37		47.24		2.883		12.095
37	9.897		0.3897		49.748		3.036		12.739
38	10.407		0.4098		52.311		3.193		13.396
39	10.928		0.4302		54.93		3.352		14.063
40	11.458		0.4511		57.594		3.515		14.746
41	11.998		0.4724		60.309		3.681		15.442
42	12.548		0.494		63.073		3.849		16.149
43	13.107		0.516		65.883		4.02		16.868
44	13.675		0.5384		68.738		4.195		17.6
45	14.251		0.5611		71.634		4.372		18.342
46	14.836		0.5841		74.574		4.551		19.094
47	15.429		0.6075		77.555		4.733		19.859
48	16.031		0.6311		80.581		4.917		20.63
49	16.639		0.6551		83.637		5.104		21.415
50	17.255		0.6794		86.733		5.293		22.209
51	17.879		0.7039		89.87		5.484		23.01
52	18.508		0.7287		93.032		5.677		23.821
53	19.145		0.7538		96.233		5.873		24.641
54	19.788		0.7791		99.466		6.07		25.468
55	20.436		0.8046		102.723		6.269		26.302
56	21.09		0.8304		106.01		6.47		27.145
57	21.75		0.8563		109.328		6.672		27.992
58	22.415		0.8825		112.67		6.876		28.848
59	23.084		0.9088		116.033		7.081		29.708
60	23.758		0.9354		119.421		7.288		30.578

VI. CRANKSHAFT DEGREES, PISTON TRAVEL, and CYLINDER DISPLACEMENT TABLE, 61 to 120-Degrees

(17)	(18)		(19)		(20)		(21)		(22)
CRANKSHAFT ROTATION FROM TDC:	PISTON TRAVEL FROM TDC:				SINGLE CYLINDER DISPLACEMENT FROM TDC:				
Degrees	Millimeters		Inches		CC's		CuIn		Percent
61	24.436	...	0.9621	...	122.829	...	7.496	...	31.45
62	25.118	...	0.9889	...	126.257	...	7.705	...	32.327
63	25.803	...	1.0159	...	129.7	...	7.915	...	33.209
64	26.492	...	1.043	...	133.164	...	8.126	...	34.095
65	27.184	...	1.0703	...	136.642	...	8.339	...	34.987
66	27.879	...	1.0976	...	140.135	...	8.552	...	35.88
67	28.576	...	1.1251	...	143.639	...	8.766	...	36.779
68	29.275	...	1.1526	...	147.153	...	8.98	...	37.678
69	29.977	...	1.1802	...	150.681	...	9.195	...	38.58
70	30.679	...	1.2079	...	154.21	...	9.411	...	39.485
71	31.383	...	1.2356	...	157.749	...	9.627	...	40.391
72	32.089	...	1.2634	...	161.297	...	9.843	...	41.3
73	32.795	...	1.2911	...	164.846	...	10.059	...	42.205
74	33.501	...	1.319	...	168.395	...	10.277	...	43.117
75	34.208	...	1.3468	...	171.949	...	10.493	...	44.026
76	34.914	...	1.3746	...	175.497	...	10.71	...	44.935
77	35.62	...	1.4024	...	179.046	...	10.926	...	45.844
78	36.326	...	1.4302	...	182.595	...	11.143	...	46.752
79	37.031	...	1.4579	...	186.139	...	11.359	...	47.658
80	37.735	...	1.4856	...	189.677	...	11.575	...	48.563
81	38.437	...	1.5133	...	193.206	...	11.79	...	49.469
82	39.138	...	1.5409	...	196.73	...	12.005	...	50.371
83	39.837	...	1.5684	...	200.243	...	12.22	...	51.27
84	40.534	...	1.5959	...	203.747	...	12.434	...	52.169
85	41.229	...	1.6232	...	207.24	...	12.647	...	53.061
86	41.921	...	1.6505	...	210.718	...	12.859	...	53.954
87	42.611	...	1.6776	...	214.187	...	13.07	...	54.84
88	43.297	...	1.7046	...	217.635	...	13.281	...	55.722
89	43.98	...	1.7315	...	221.068	...	13.49	...	56.602
90	44.66	...	1.7583	...	224.486	...	13.699	...	57.478
91	45.337	...	1.7849	...	227.889	...	13.906	...	58.347
92	46.009	...	1.8114	...	231.267	...	14.113	...	59.213
93	46.677	...	1.8377	...	234.625	...	14.318	...	60.073
94	47.342	...	1.8639	...	237.967	...	14.522	...	60.93
95	48.001	...	1.8898	...	241.28	...	14.724	...	61.776
96	48.656	...	1.9156	...	244.572	...	14.925	...	62.62
97	49.307	...	1.9412	...	247.845	...	15.124	...	63.457
98	49.952	...	1.9666	...	251.087	...	15.322	...	64.287
99	50.593	...	1.9919	...	254.309	...	15.519	...	65.114
100	51.228	...	2.0169	...	257.501	...	15.714	...	65.931
101	51.857	...	2.0416	...	260.662	...	15.906	...	66.739
102	52.481	...	2.0662	...	263.799	...	16.098	...	67.543
103	53.099	...	2.0906	...	266.905	...	16.288	...	68.34
104	53.712	...	2.1147	...	269.987	...	16.476	...	69.128
105	54.318	...	2.1385	...	273.033	...	16.661	...	69.906
106	54.918	...	2.1622	...	276.049	...	16.846	...	70.681
107	55.512	...	2.1855	...	279.034	...	17.028	...	71.443
108	56.1	...	2.2087	...	281.99	...	17.208	...	72.201
109	56.68	...	2.2315	...	284.905	...	17.386	...	72.946
110	57.255	...	2.2541	...	287.796	...	17.562	...	73.685
111	57.822	...	2.2765	...	290.646	...	17.737	...	74.417
112	58.383	...	2.2986	...	293.466	...	17.909	...	75.14
113	58.936	...	2.3204	...	296.245	...	18.079	...	75.852
114	59.483	...	2.3419	...	298.995	...	18.246	...	76.555
115	60.022	...	2.3631	...	301.704	...	18.411	...	77.248
116	60.554	...	2.384	...	304.378	...	18.574	...	77.931
117	61.079	...	2.4047	...	307.017	...	18.735	...	78.608
118	61.596	...	2.4251	...	309.616	...	18.894	...	79.275
119	62.106	...	2.4451	...	312.18	...	19.05	...	79.929
120	62.608	...	2.4649	...	314.703	...	19.204	...	80.576

VII. CRANKSHAFT DEGREES, PISTON TRAVEL, and CYLINDER DISPLACEMENT TABLE, 121 to 180-Degrees

(23)	(24)		(25)		(26)		(27)		(28)
CRANKSHAFT ROTATION FROM TDC:	PISTON TRAVEL FROM TDC:				SINGLE CYLINDER DISPLACEMENT FROM TDC:				
Degrees	Millimeters		Inches		CC's		CuIn		Percent
121	63.103	...	2.4844	...	317.191	...	19.356	...	81.213
122	63.59	...	2.5036	...	319.639	...	19.506	...	81.841
123	64.069	...	2.5224	...	322.047	...	19.652	...	82.456
124	64.54	...	2.541	...	324.414	...	19.797	...	83.064
125	65.004	...	2.5592	...	326.747	...	19.939	...	83.659
126	65.459	...	2.5772	...	329.034	...	20.079	...	84.247
127	65.907	...	2.5948	...	331.285	...	20.216	...	84.822
128	66.346	...	2.6121	...	333.492	...	20.351	...	85.388
129	66.777	...	2.6291	...	335.659	...	20.484	...	85.944
130	67.201	...	2.6457	...	337.79	...	20.613	...	86.486
131	67.616	...	2.6621	...	339.876	...	20.741	...	87.022
132	68.023	...	2.6781	...	341.922	...	20.865	...	87.545
133	68.421	...	2.6938	...	343.922	...	20.988	...	88.059
134	68.812	...	2.7092	...	345.888	...	21.108	...	88.562
135	69.194	...	2.7242	...	347.808	...	21.225	...	89.052
136	69.568	...	2.7389	...	349.688	...	21.339	...	89.533
137	69.934	...	2.7533	...	351.527	...	21.451	...	90.004
138	70.291	...	2.7674	...	353.322	...	21.561	...	90.465
139	70.64	...	2.7811	...	355.076	...	21.668	...	90.912
140	70.981	...	2.7945	...	356.79	...	21.772	...	91.35
141	71.313	...	2.8076	...	358.459	...	21.874	...	91.779
142	71.637	...	2.8204	...	360.088	...	21.974	...	92.197
143	71.952	...	2.8328	...	361.671	...	22.071	...	92.602
144	72.259	...	2.8449	...	363.214	...	22.165	...	92.998
145	72.558	...	2.8566	...	364.717	...	22.256	...	93.38
146	72.848	...	2.868	...	366.175	...	22.345	...	93.753
147	73.129	...	2.8791	...	367.587	...	22.432	...	94.116
148	73.403	...	2.8899	...	368.965	...	22.516	...	94.469
149	73.668	...	2.9003	...	370.297	...	22.597	...	94.809
150	73.924	...	2.9104	...	371.583	...	22.675	...	95.139
151	74.172	...	2.9202	...	372.83	...	22.752	...	95.459
152	74.412	...	2.9296	...	374.036	...	22.825	...	95.767
153	74.643	...	2.9387	...	375.198	...	22.896	...	96.064
154	74.865	...	2.9475	...	376.313	...	22.964	...	96.352
155	75.079	...	2.9559	...	377.389	...	23.03	...	96.626
156	75.285	...	2.964	...	378.425	...	23.093	...	96.891
157	75.483	...	2.9718	...	379.42	...	23.154	...	97.146
158	75.672	...	2.9792	...	380.37	...	23.211	...	97.388
159	75.852	...	2.9863	...	381.275	...	23.267	...	97.62
160	76.024	...	2.9931	...	382.139	...	23.32	...	97.843
161	76.188	...	2.9995	...	382.964	...	23.37	...	98.052
162	76.343	...	3.0056	...	383.743	...	23.417	...	98.251
163	76.49	...	3.0114	...	384.482	...	23.462	...	98.441
164	76.628	...	3.0169	...	385.175	...	23.505	...	98.621
165	76.758	...	3.022	...	385.829	...	23.545	...	98.787
166	76.88	...	3.0268	...	386.442	...	23.582	...	98.944
167	76.993	...	3.0312	...	387.01	...	23.617	...	99.088
168	77.097	...	3.0354	...	387.533	...	23.649	...	99.225
169	77.194	...	3.0392	...	388.02	...	23.679	...	99.349
170	77.282	...	3.0426	...	388.463	...	23.705	...	99.461
171	77.361	...	3.0457	...	388.86	...	23.73	...	99.562
172	77.433	...	3.0486	...	389.222	...	23.752	...	99.657
173	77.495	...	3.051	...	389.533	...	23.771	...	99.735
174	77.55	...	3.0532	...	389.81	...	23.788	...	99.807
175	77.596	...	3.055	...	390.041	...	23.802	...	99.866
176	77.634	...	3.0565	...	390.232	...	23.814	...	99.915
177	77.663	...	3.0576	...	390.378	...	23.822	...	99.951
178	77.684	...	3.0584	...	390.483	...	23.828	...	99.977
179	77.696	...	3.0589	...	390.544	...	23.832	...	99.993
180	77.7	...	3.0591	...	390.564	...	23.834	...	100

VIII. RPM, PISTON SPEED and ACCELERATION, and CRANK ROTATION TIME-PERIOD TABLE

(28) 29 CRANK-SHAFT RPM	(29) 30 MEAN PISTON SPEED: Ft/Min	(30) 31 PEAK PISTON SPEED: Ft/Min	(31) 32 MAXIMUM PISTON ACCEL-ERATION: Ft/Sec-Sec	(32) 33 ROD BIG-END LINEAR-SPEED AROUND STROKE CIRCLE: Ft/Min	(33) 34 TIME-PERIOD FOR 1-DEGREE OF CRANKSHAFT ROTATION: Seconds
6000	3059	5005	65046	4805	.00002778
6100	3110	5090	67232	4885	.00002732
6200	3161	5173	69454	4965	.00002688
6300	3212	5255	71713	5045	.00002646
6400	3263	5340	74007	5126	.00002604
6500	3314	5423	76338	5206	.00002564
6600	3365	5507	78705	5286	.00002525
6700	3416	5589	81108	5366	.00002488
6800	3467	5673	83548	5446	.00002451
6900	3518	5758	86023	5526	.00002415
7000	3569	5840	88534	5606	.00002381
7100	3620	5925	91082	5686	.00002347
7200	3671	6006	93666	5766	.00002315
7300	3722	6091	96286	5846	.00002283
7400	3773	6175	98942	5926	.00002252
7500	3824	6258	101634	6007	.00002222
7600	3875	6341	104362	6087	.00002193
7700	3926	6423	107127	6167	.00002165
7800	3977	6507	109927	6247	.00002137
7900	4028	6590	112764	6327	.0000211
8000	4079	6675	115637	6407	.00002083
8100	4130	6757	118546	6487	.00002058
8200	4181	6840	121491	6567	.00002033
8300	4232	6925	124472	6647	.00002008
8400	4283	7009	127489	6727	.00001984
8500	4334	7091	130543	6807	.00001961
8600	4385	7175	133633	6887	.00001938
8700	4436	7257	136758	6968	.00001916
8800	4487	7342	139920	7048	.00001894
8900	4538	7424	143118	7128	.00001873
9000	4589	7508	146353	7208	.00001852
9100	4640	7590	149623	7288	.00001832
9200	4691	7674	152930	7368	.00001812
9300	4742	7759	156272	7448	.00001792
9400	4793	7843	159651	7528	.00001773
9500	4844	7928	163066	7608	.00001754
9600	4895	8010	166517	7688	.00001736
9700	4946	8094	170004	7768	.00001718
9800	4997	8175	173527	7849	.00001701
9900	5048	8257	177087	7929	.00001684
10000	5098	8341	180682	8009	.00001667
10100	5149	8427	184314	8089	.0000165
10200	5200	8510	187982	8169	.00001634
10300	5251	8594	191686	8249	.00001618
10400	5302	8674	195426	8329	.00001603
10500	5353	8762	199202	8409	.00001587
10600	5404	8845	203015	8489	.00001572
10700	5455	8925	206863	8569	.00001558
10800	5506	9012	210748	8649	.00001543
10900	5557	9094	214669	8729	.00001529
11000	5608	9178	218626	8810	.00001515

NOTE: To find a TIME-factor, in seconds, for any desired degree spread of crankshaft rotation, for any desired RPM: select a TIME-PERIOD (Col. 34), which corresponds to the desired RPM (Col. 29), & multiply that TIME-PERIOD by the desired degree spread of crankshaft rotation.
EXAMPLE: 296-degrees @ 9000-rpm: (.00001852 --from Col. 29 for 9000-rpm) (296-degrees) = .005476-seconds

IX. MEAN and PEAK PISTON SPEED and SINGLE CYLINDER CFM TABLE at VARIOUS PEAK TORQUE RPM (CFM CALCULATED for 100% VOLUMETRIC EFFICIENCY)

(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)
IF PEAK TORQUE RPM IS:	MEAN PISTON SPEED IS: Ft/Min	PEAK PISTON SPEED IS: Ft/Min	PEAK PISTON SPEED CFM IS:	SINGLE CYLINDER CFM IN 5-DEGREE INCREMENTS ATDC OF INTAKE STROKE (AREA OF MAXIMUM INTAKE VALVE LIFT): 90- Deg.	95- Deg.	100- Deg.	105- Deg.	110- Deg.	115- Deg.	120- Deg.
7800	3977	6507	352.1	338.9	328.8	316.5	302.2	286.3	268.8	250.3
7850	4002	6550	354.3	341.1	330.9	318.5	304.1	288.1	270.5	251.9
7900	4028	6590	356.6	343.3	333	320.6	306.1	289.9	272.2	253.5
7950	4053	6634	358.9	345.4	335.1	322.6	308	291.8	274	255.1
8000	4079	6675	361.1	347.6	337.2	324.6	310	293.6	275.7	256.7
8050	4104	6717	363.4	349.8	339.3	326.7	311.9	295.4	277.4	258.3
8100	4130	6757	365.6	352	341.4	328.7	313.8	297.3	279.1	259.9
8150	4155	6800	367.9	354.1	343.6	330.7	315.8	299.1	280.8	261.5
8200	4181	6840	370.1	356.3	345.7	332.7	317.7	300.9	282.6	263.1
8250	4206	6884	372.4	358.5	347.8	334.8	319.6	302.8	284.3	264.7
8300	4232	6925	374.7	360.7	349.9	336.8	321.6	304.6	286	266.3
8350	4257	6966	376.9	362.8	352	338.8	323.5	306.4	287.7	267.9
8400	4283	7009	379.2	365	354.1	340.9	325.5	308.3	289.5	269.6
8450	4308	7051	381.4	367.2	356.2	342.9	327.4	310.1	291.2	271.2
8500	4334	7091	383.7	369.3	358.3	344.9	329.3	311.9	292.9	272.8
8550	4359	7134	385.9	371.5	360.4	346.9	331.3	313.8	294.6	274.4
8600	4385	7175	388.2	373.7	362.5	349	333.2	315.6	296.4	276
8650	4410	7216	390.5	375.9	364.6	351	335.1	317.5	298.1	277.6
8700	4436	7257	392.7	378	366.7	353	337.1	319.3	299.8	279.2
8750	4461	7299	395	380.2	368.8	355.1	339	321.1	301.5	280.8
8800	4487	7342	397.2	382.4	370.9	357.1	341	323	303.2	282.4
8850	4512	7384	399.5	384.5	373.1	359.1	342.9	324.8	305	284
8900	4538	7424	401.7	386.7	375.2	361.2	344.8	326.6	306.7	285.6
8950	4563	7468	404	388.9	377.3	363.2	346.8	328.5	308.4	287.2
9000	4589	7508	406.3	391.1	379.4	365.2	348.7	330.3	310.1	288.8
9050	4614	7549	408.5	393.2	381.5	367.2	350.6	332.1	311.9	290.4
9100	4640	7590	410.8	395.4	383.6	369.3	352.6	334	313.6	292
9150	4665	7636	413	397.6	385.7	371.3	354.5	335.8	315.3	293.6
9200	4691	7674	415.3	399.8	387.8	373.3	356.5	337.6	317	295.2
9250	4716	7716	417.5	401.9	389.9	375.4	358.4	339.5	318.8	296.8
9300	4742	7759	419.8	404.1	392	377.4	360.3	341.3	320.5	298.4
9350	4767	7799	422.1	406.3	394.1	379.4	362.3	343.1	322.2	300
9400	4793	7843	424.3	408.4	396.2	381.4	364.2	345	323.9	301.6
9450	4818	7883	426.6	410.6	398.3	383.5	366.1	346.8	325.6	303.2
9500	4844	7928	428.8	412.8	400.5	385.5	368.1	348.6	327.4	304.9
9550	4869	7968	431.1	415	402.6	387.5	370	350.5	329.1	306.5
9600	4895	8010	433.3	417.1	404.7	389.6	371.9	352.3	330.8	308.1
9650	4920	8052	435.6	419.3	406.8	391.6	373.9	354.2	332.5	309.7
9700	4946	8094	437.9	421.5	408.9	393.6	375.8	356	334.3	311.3
9750	4971	8136	440.1	423.7	411	395.6	377.8	357.8	336	312.9
9800	4997	8175	442.4	425.8	413.1	397.7	379.7	359.7	337.7	314.5
9850	5022	8218	444.6	428	415.2	399.7	381.6	361.5	339.4	316.1
9900	5048	8257	446.9	430.2	417.3	401.7	383.6	363.3	341.2	317.7
9950	5073	8301	449.1	432.3	419.4	403.8	385.5	365.2	342.9	319.3
10000	5098	8341	451.4	434.5	421.5	405.8	387.4	367	344.6	320.9
10050	5124	8387	453.7	436.7	423.6	407.8	389.4	368.8	346.3	322.5
10100	5149	8427	455.9	438.9	425.7	409.8	391.3	370.7	348	324.1
10150	5175	8468	458.2	441	427.9	411.9	393.3	372.5	349.8	325.7
10200	5200	8510	460.4	443.2	430	413.9	395.2	374.3	351.5	327.3
10250	5226	8552	462.7	445.4	432.1	415.9	397.1	376.2	353.2	328.9
10300	5251	8594	464.9	447.6	434.2	418	399.1	378	354.9	330.5

X. SINGLE CYLINDER CFM TABLE for VARIOUS VOLUMETRIC EFFICIENCY (Ve) PERCENTAGES at THE PEAK PISTON SPEED OCCURENCE

Peak Piston Speed occurence for this engine: 73.692-degrees BTDC/ATDC.

(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)	(55)	(56)
IF PEAK TORQUE RPM IS:	PEAK PISTON SPEED CFM @ 100%-Ve	CFM @ 50% Ve	CFM @ 60% Ve	CFM @ 70% Ve	CFM @ 80% Ve	CFM @ 90% Ve	CFM @ 100% Ve	CFM @ 110% Ve	CFM @ 120% Ve	CFM @ 130% Ve
7800	352.1	176.1	211.3	246.5	281.7	316.9	352.1	387.3	422.5	457.7
7850	354.3	177.2	212.6	248	283.4	318.9	354.3	389.7	425.2	460.6
7900	356.6	178.3	214	249.6	285.3	320.9	356.6	392.3	427.9	463.6
7950	358.9	179.5	215.3	251.2	287.1	323	358.9	394.8	430.7	466.6
8000	361.1	180.6	216.7	252.8	288.9	325	361.1	397.2	433.3	469.4
8050	363.4	181.7	218	254.4	290.7	327.1	363.4	399.7	436.1	472.4
8100	365.6	182.8	219.4	255.9	292.5	329	365.6	402.2	438.7	475.3
8150	367.9	184	220.7	257.5	294.3	331.1	367.9	404.7	441.5	478.3
8200	370.1	185.1	222.1	259.1	296.1	333.1	370.1	407.1	444.1	481.1
8250	372.4	186.2	223.4	260.7	297.9	335.2	372.4	409.6	446.9	484.1
8300	374.7	187.4	224.8	262.3	299.8	337.2	374.7	412.2	449.6	487.1
8350	376.9	188.5	226.1	263.8	301.5	339.2	376.9	414.6	452.3	490
8400	379.2	189.6	227.5	265.4	303.4	341.3	379.2	417.1	455	493
8450	381.4	190.7	228.8	267	305.1	343.3	381.4	419.5	457.7	495.8
8500	383.7	191.9	230.2	268.6	307	345.3	383.7	422.1	460.4	498.8
8550	385.9	193	231.5	270.1	308.7	347.3	385.9	424.5	463.1	501.7
8600	388.2	194.1	232.9	271.7	310.6	349.4	388.2	427	465.8	504.7
8650	390.5	195.3	234.3	273.4	312.4	351.5	390.5	429.6	468.6	507.7
8700	392.7	196.4	235.6	274.9	314.2	353.4	392.7	432	471.2	510.5
8750	395	197.5	237	276.5	316	355.5	395	434.5	474	513.5
8800	397.2	198.6	238.3	278	317.8	357.5	397.2	436.9	476.6	516.4
8850	399.5	199.8	239.7	279.7	319.6	359.6	399.5	439.5	479.4	519.4
8900	401.7	200.9	241	281.2	321.4	361.5	401.7	441.9	482	522.2
8950	404	202	242.4	282.8	323.2	363.6	404	444.4	484.8	525.2
9000	406.3	203.2	243.8	284.4	325	365.7	406.3	446.9	487.6	528.2
9050	408.5	204.3	245.1	286	326.8	367.7	408.5	449.4	490.2	531.1
9100	410.8	205.4	246.5	287.6	328.6	369.7	410.8	451.9	493	534
9150	413	206.5	247.8	289.1	330.4	371.7	413	454.3	495.6	536.9
9200	415.3	207.7	249.2	290.7	332.2	373.8	415.3	456.8	498.4	539.9
9250	417.5	208.8	250.5	292.3	334	375.8	417.5	459.3	501	542.8
9300	419.8	209.9	251.9	293.9	335.8	377.8	419.8	461.8	503.8	545.7
9350	422.1	211.1	253.3	295.5	337.7	379.9	422.1	464.3	506.5	548.7
9400	424.3	212.2	254.6	297	339.4	381.9	424.3	466.7	509.2	551.6
9450	426.6	213.3	256	298.6	341.3	383.9	426.6	469.3	511.9	554.6
9500	428.8	214.4	257.3	300.2	343	385.9	428.8	471.7	514.6	557.4
9550	431.1	215.6	258.7	301.8	344.9	388	431.1	474.2	517.3	560.4
9600	433.3	216.7	260	303.3	346.6	390	433.3	476.6	520	563.3
9650	435.6	217.8	261.4	304.9	348.5	392	435.6	479.2	522.7	566.3
9700	437.9	219	262.7	306.5	350.3	394.1	437.9	481.7	525.5	569.3
9750	440.1	220.1	264.1	308.1	352.1	396.1	440.1	484.1	528.1	572.1
9800	442.4	221.2	265.4	309.7	353.9	398.2	442.4	486.6	530.9	575.1
9850	444.6	222.3	266.8	311.2	355.7	400.1	444.6	489.1	533.5	578
9900	446.9	223.5	268.1	312.8	357.5	402.2	446.9	491.6	536.3	581
9950	449.1	224.6	269.5	314.4	359.3	404.2	449.1	494	538.9	583.8
10000	451.4	225.7	270.8	316	361.1	406.3	451.4	496.5	541.7	586.8
10050	453.7	226.9	272.2	317.6	363	408.3	453.7	499.1	544.4	589.8
10100	455.9	228	273.5	319.1	364.7	410.3	455.9	501.5	547.1	592.7
10150	458.2	229.1	274.9	320.7	366.6	412.4	458.2	504	549.8	595.7
10200	460.4	230.2	276.2	322.3	368.3	414.4	460.4	506.4	552.5	598.5
10250	462.7	231.4	277.6	323.9	370.2	416.4	462.7	509	555.2	601.5
10300	464.9	232.5	278.9	325.4	371.9	418.4	464.9	511.4	557.9	604.4

XI. COMPRESSION RATIO and TRAPPED CYLINDER HEAD VOLUME TABLE

(57) COMPRESSION RATIO	(58) TRAPPED CYLINDER HEAD VOLUME AT TDC: cc's	(59) COMPRESSION RATIO	(60) TRAPPED CYLINDER HEAD VOLUME AT TDC: cc's	(61) COMPRESSION RATIO	(62) TRAPPED CYLINDER HEAD VOLUME AT TDC: cc's	(63) COMPRESSION RATIO	(64) TRAPPED CYLINDER HEAD VOLUME AT TDC: cc's
9 :1	= 48.82	11 :1	= 39.06	13 :1	= 32.55	15 :1	= 27.9
9.1 :1	= 48.22	11.1 :1	= 38.67	13.1 :1	= 32.28	15.1 :1	= 27.7
9.2 :1	= 47.63	11.2 :1	= 38.29	13.2 :1	= 32.01	15.2 :1	= 27.5
9.3 :1	= 47.06	11.3 :1	= 37.92	13.3 :1	= 31.75	15.3 :1	= 27.31
9.4 :1	= 46.5	11.4 :1	= 37.55	13.4 :1	= 31.5	15.4 :1	= 27.12
9.5 :1	= 45.95	11.5 :1	= 37.2	13.5 :1	= 31.25	15.5 :1	= 26.94
9.6 :1	= 45.41	11.6 :1	= 36.85	13.6 :1	= 31	15.6 :1	= 26.75
9.7 :1	= 44.89	11.7 :1	= 36.5	13.7 :1	= 30.75	15.7 :1	= 26.57
9.8 :1	= 44.38	11.8 :1	= 36.16	13.8 :1	= 30.51	15.8 :1	= 26.39
9.9 :1	= 43.88	11.9 :1	= 35.83	13.9 :1	= 30.28	15.9 :1	= 26.21
10 :1	= 43.4	12 :1	= 35.51	14 :1	= 30.04	16 :1	= 26.04
10.1 :1	= 42.92	12.1 :1	= 35.19	14.1 :1	= 29.81	16.1 :1	= 25.87
10.2 :1	= 42.45	12.2 :1	= 34.87	14.2 :1	= 29.59	16.2 :1	= 25.69
10.3 :1	= 42	12.3 :1	= 34.56	14.3 :1	= 29.37	16.3 :1	= 25.53
10.4 :1	= 41.55	12.4 :1	= 34.26	14.4 :1	= 29.15	16.4 :1	= 25.36
10.5 :1	= 41.11	12.5 :1	= 33.96	14.5 :1	= 28.93	16.5 :1	= 25.2
10.6 :1	= 40.68	12.6 :1	= 33.67	14.6 :1	= 28.72	16.6 :1	= 25.04
10.7 :1	= 40.26	12.7 :1	= 33.38	14.7 :1	= 28.51	16.7 :1	= 24.88
10.8 :1	= 39.85	12.8 :1	= 33.1	14.8 :1	= 28.3	16.8 :1	= 24.72
10.9 :1	= 39.45	12.9 :1	= 32.82	14.9 :1	= 28.1	16.9 :1	= 24.56

XII. BORE and STROKE ALTERATION TABLE for A GIVEN ENGINE DISPLACEMENT RANGE

(65) TOTAL ENGINE DISPLACEMENT (cc)	(66)	(67)	(68)	(69)	(70)	(71)	(72)	(73)	(74)	(75)
					STROKE (mm)					
	ZZ	ZZ.1	ZZ.2	ZZ.3	ZZ.4	ZZ.5	ZZ.6	ZZ.7	ZZ.8	ZZ.9
1560 ..	80.3	80.25	80.2	80.15	80.1	80.05	79.99	79.94	79.89	79.84
1561 ..	80.33	80.28	80.23	80.17	80.12	80.07	80.02	79.97	79.92	79.87
1562 ..	80.36	80.3	80.25	80.2	80.15	80.1	80.05	79.99	79.94	79.89
1563 ..	80.38	80.33	80.28	80.23	80.17	80.12	80.07	80.02	79.97	79.92
1564 ..	80.41	80.36	80.3	80.25	80.2	80.15	80.1	80.04	79.99	79.94
1565 ..	80.43	80.38	80.33	80.28	80.23	80.17	80.12	80.07	80.02	79.97
1566 ..	80.46	80.41	80.35	80.3	80.25	80.2	80.15	80.1	80.04	79.99
1567 ..	80.48	80.43	80.38	80.33	80.28	80.22	80.17	80.12	80.07	80.02
1568 ..	80.51	80.46	80.41	80.35	80.3	80.25	80.2	80.15	80.1	80.04
1569 ..	80.54	80.48	80.43	80.38	80.33	80.28	80.22	80.17	80.12	80.07
1570 ..	80.56	80.51	80.46	80.41	80.35	80.3	80.25	80.2	80.15	80.1

SINGLE CYLINDER BORE (mm)

			STROKE (mm)							
	Z8	Z8.1	Z8.2	Z8.3	Z8.4	Z8.5	Z8.6	Z8.7	Z8.8	Z8.9
1571 ..	80.07	80.02	79.97	79.92	79.86	79.81	79.76	79.71	79.66	79.61
1572 ..	80.09	80.04	79.99	79.94	79.89	79.84	79.79	79.74	79.69	79.64
1573 ..	80.12	80.07	80.02	79.97	79.92	79.86	79.81	79.76	79.71	79.66
1574 ..	80.15	80.09	80.04	79.99	79.94	79.89	79.84	79.79	79.74	79.69
1575 ..	80.17	80.12	80.07	80.02	79.97	79.92	79.86	79.81	79.76	79.71
1576 ..	80.2	80.15	80.09	80.04	79.99	79.94	79.89	79.84	79.79	79.74
1577 ..	80.22	80.17	80.12	80.07	80.02	79.97	79.92	79.86	79.81	79.76
1578 ..	80.25	80.2	80.14	80.09	80.04	79.99	79.94	79.89	79.84	79.79
1579 ..	80.27	80.22	80.17	80.12	80.07	80.02	79.97	79.91	79.86	79.81
1580 ..	80.3	80.25	80.2	80.14	80.09	80.04	79.99	79.94	79.89	79.84
1581 ..	80.32	80.27	80.22	80.17	80.12	80.07	80.02	79.97	79.91	79.86

SINGLE CYLINDER BORE (mm)

XIII. BORE and STROKE ALTERATION TABLE for VARIOUS ENGINE DISPLACEMENTS

(76)	(77)	(78)	(79)	(80)	(81)	(82)
BORE (mm)	STROKE (mm)					
	77.7	77.9	78.1	78.3	78.5	78.7
78	371.28 (1485.1) *1.0039:1*	372.24 (1488.9) *1.0013:1*	373.19 (1492.8) *0.9987:1*	374.15 (1496.6) *0.9962:1*	375.1 (1500.4) *0.9936:1*	376.06 (1504.2) *0.9911:1*
78.2	373.19 (1492.7) *1.0064:1*	374.15 (1496.6) *1.0039:1*	375.11 (1500.4) *1.0013:1*	376.07 (1504.3) *0.9987:1*	377.03 (1508.1) *0.9962:1*	377.99 (1512) *0.9936:1*
78.4	375.1 (1500.4) *1.009:1*	376.06 (1504.3) *1.0064:1*	377.03 (1508.1) *1.0038:1*	377.99 (1512) *1.0013:1*	378.96 (1515.8) *0.9987:1*	379.92 (1519.7) *0.9962:1*
78.6	377.01 (1508.1) *1.0116:1*	377.98 (1511.9) *1.009:1*	378.95 (1515.8) *1.0064:1*	379.92 (1519.7) *1.0038:1*	380.9 (1523.6) *1.0013:1*	381.87 (1527.5) *0.9987:1*
78.8	378.93 (1515.7) *1.0142:1*	379.91 (1519.6) *1.0116:1*	380.89 (1523.5) *1.009:1*	381.86 (1527.4) *1.0064:1*	382.84 (1531.3) *1.0038:1*	383.81 (1535.2) *1.0013:1*
79	380.86 (1523.4) *1.0167:1*	381.84 (1527.4) *1.0141:1*	382.82 (1531.3) *1.0115:1*	383.8 (1535.2) *1.0089:1*	384.78 (1539.1) *1.0064:1*	385.76 (1543) *1.0038:1*
79.2	382.79 (1531.2) *1.0193:1*	383.78 (1535.1) *1.0167:1*	384.76 (1539) *1.0141:1*	385.75 (1543) *1.0115:1*	386.73 (1546.9) *1.0089:1*	387.72 (1550.9) *1.0064:1*
79.4	384.73 (1538.9) *1.0219:1*	385.72 (1542.9) *1.0193:1*	386.71 (1546.8) *1.0166:1*	387.7 (1550.8) *1.014:1*	388.69 (1554.8) *1.0115:1*	389.68 (1558.7) *1.0089:1*
79.6	386.67 (1546.7) *1.0245:1*	387.66 (1550.7) *1.0218:1*	388.66 (1554.6) *1.0192:1*	389.65 (1558.6) *1.0166:1*	390.65 (1562.6) *1.014:1*	391.64 (1566.6) *1.0114:1*
79.8	388.61 (1554.5) *1.027:1*	389.61 (1558.5) *1.0244:1*	390.61 (1562.5) *1.0218:1*	391.61 (1566.5) *1.0192:1*	392.61 (1570.5) *1.0166:1*	393.61 (1574.5) *1.014:1*
80	390.56 (1562.3) *1.0296:1*	391.57 (1566.3) *1.027:1*	392.57 (1570.3) *1.0243:1*	393.58 (1574.3) *1.0217:1*	394.58 (1578.3) *1.0191:1*	395.59 (1582.4) *1.0165:1*
80.2	392.52 (1570.1) *1.0322:1*	393.53 (1574.1) *1.0295:1*	394.54 (1578.2) *1.0269:1*	395.55 (1582.2) *1.0243:1*	396.56 (1586.2) *1.0217:1*	397.57 (1590.3) *1.0191:1*
80.4	394.48 (1577.9) *1.0347:1*	395.49 (1582) *1.0321:1*	396.51 (1586) *1.0294:1*	397.53 (1590.1) *1.0268:1*	398.54 (1594.2) *1.0242:1*	399.56 (1598.2) *1.0216:1*
80.6	396.44 (1585.8) *1.0373:1*	397.46 (1589.9) *1.0347:1*	398.49 (1593.9) *1.032:1*	399.51 (1598) *1.0294:1*	400.53 (1602.1) *1.0268:1*	401.55 (1606.2) *1.0241:1*
80.8	398.41 (1593.7) *1.0399:1*	399.44 (1597.8) *1.0372:1*	400.47 (1601.9) *1.0346:1*	401.49 (1606) *1.0319:1*	402.52 (1610.1) *1.0293:1*	403.54 (1614.2) *1.0267:1*
81	400.39 (1601.6) *1.0425:1*	401.42 (1605.7) *1.0398:1*	402.45 (1609.8) *1.0371:1*	403.48 (1613.9) *1.0345:1*	404.51 (1618) *1.0318:1*	405.54 (1622.2) *1.0292:1*
81.2	402.37 (1609.5) *1.045:1*	403.4 (1613.6) *1.0424:1*	404.44 (1617.8) *1.0397:1*	405.48 (1621.9) *1.037:1*	406.51 (1626) *1.0344:1*	407.55 (1630.2) *1.0318:1*
81.4	404.35 (1617.4) *1.0476:1*	405.39 (1621.6) *1.0449:1*	406.43 (1625.7) *1.0423:1*	407.48 (1629.9) *1.0396:1*	408.52 (1634.1) *1.0369:1*	409.56 (1638.2) *1.0343:1*
81.6	406.34 (1625.4) *1.0502:1*	407.39 (1629.6) *1.0475:1*	408.43 (1633.7) *1.0448:1*	409.48 (1637.9) *1.0421:1*	410.53 (1642.1) *1.0395:1*	411.57 (1646.3) *1.0368:1*
81.8	408.34 (1633.3) *1.0528:1*	409.39 (1637.6) *1.0501:1*	410.44 (1641.8) *1.0474:1*	411.49 (1646) *1.0447:1*	412.54 (1650.2) *1.042:1*	413.59 (1654.4) *1.0394:1*
82	410.34 (1641.3) *1.0553:1*	411.39 (1645.6) *1.0526:1*	412.45 (1649.8) *1.0499:1*	413.5 (1654) *1.0473:1*	414.56 (1658.2) *1.0446:1*	415.62 (1662.5) *1.0419:1*

SINGLE CYLINDER DISPLACEMENT (cc)
(TOTAL ENGINE DISPLACEMENT)
Bore-to-Stroke Ratio in Italics

XIV. ROD LENGTH and STROKE ALTERATION TABLE

The peak piston speed in more than 95% of all reciprocating engines occurs between 71 and 79-degrees Before and After TDC. The following table provides part of this range using the stroke values in Section XIII.

(83)	(84)	(85)	(86)	(87)	(88)	(89)
ROD LENGTH (mm)	STROKE (mm)					
	77.7	77.9	78.1	78.3	78.5	78.7
127	.... 72.991 *1.6345:1*	72.95 *1.6303:1*	72.908 *1.6261:1*	72.867 *1.622:1*	72.826 *1.6178:1*	72.785 *1.6137:1*
128	.... 73.116 *1.6474:1*	73.075 *1.6431:1*	73.034 *1.6389:1*	72.993 *1.6347:1*	72.952 *1.6306:1*	72.911 *1.6264:1*
129	.... 73.24 *1.6602:1*	73.199 *1.656:1*	73.158 *1.6517:1*	73.118 *1.6475:1*	73.077 *1.6433:1*	73.036 *1.6391:1*
130	.... 73.361 *1.6731:1*	73.321 *1.6688:1*	73.281 *1.6645:1*	73.24 *1.6603:1*	73.2 *1.6561:1*	73.159 *1.6518:1*
131	.... 73.481 *1.686:1*	73.441 *1.6816:1*	73.401 *1.6773:1*	73.361 *1.6731:1*	73.321 *1.6688:1*	73.281 *1.6645:1*
132	.... 73.6 *1.6988:1*	73.56 *1.6945:1*	73.52 *1.6901:1*	73.48 *1.6858:1*	73.44 *1.6815:1*	73.4 *1.6773:1*
133	.... 73.717 *1.7117:1*	73.677 *1.7073:1*	73.637 *1.7029:1*	73.598 *1.6986:1*	73.558 *1.6943:1*	73.518 *1.69:1*
134	.... 73.832 *1.7246:1*	73.792 *1.7202:1*	73.753 *1.7157:1*	73.714 *1.7114:1*	73.674 *1.707:1*	73.635 *1.7027:1*
135	.... 73.945 *1.7375:1*	73.906 *1.733:1*	73.867 *1.7286:1*	73.828 *1.7241:1*	73.789 *1.7197:1*	73.75 *1.7154:1*
136	.... 74.057 *1.7503:1*	74.018 *1.7458:1*	73.98 *1.7414:1*	73.941 *1.7369:1*	73.902 *1.7325:1*	73.863 *1.7281:1*
137	.... 74.168 *1.7632:1*	74.129 *1.7587:1*	74.091 *1.7542:1*	74.052 *1.7497:1*	74.013 *1.7452:1*	73.975 *1.7408:1*
138	.... 74.277 *1.7761:1*	74.238 *1.7715:1*	74.2 *1.767:1*	74.162 *1.7625:1*	74.123 *1.758:1*	74.085 *1.7535:1*
139	.... 74.385 *1.7889:1*	74.346 *1.7843:1*	74.308 *1.7798:1*	74.27 *1.7752:1*	74.232 *1.7707:1*	74.194 *1.7662:1*
140	.... 74.491 *1.8018:1*	74.453 *1.7972:1*	74.415 *1.7926:1*	74.377 *1.788:1*	74.339 *1.7834:1*	74.301 *1.7789:1*
141	.... 74.595 *1.8147:1*	74.558 *1.81:1*	74.52 *1.8054:1*	74.482 *1.8008:1*	74.444 *1.7962:1*	74.407 *1.7916:1*
142	.... 74.699 *1.8275:1*	74.661 *1.8228:1*	74.624 *1.8182:1*	74.586 *1.8135:1*	74.549 *1.8089:1*	74.511 *1.8043:1*
143	.... 74.801 *1.8404:1*	74.764 *1.8357:1*	74.726 *1.831:1*	74.689 *1.8263:1*	74.652 *1.8217:1*	74.614 *1.817:1*
144	.... 74.902 *1.8533:1*	74.864 *1.8485:1*	74.827 *1.8438:1*	74.79 *1.8391:1*	74.753 *1.8344:1*	74.716 *1.8297:1*
145	.... 75.001 *1.8662:1*	74.964 *1.8614:1*	74.927 *1.8566:1*	74.89 *1.8519:1*	74.854 *1.8471:1*	74.817 *1.8424:1*
146	.... 75.099 *1.879:1*	75.062 *1.8742:1*	75.026 *1.8694:1*	74.989 *1.8646:1*	74.953 *1.8599:1*	74.916 *1.8551:1*
147	.... 75.196 *1.8919:1*	75.16 *1.887:1*	75.123 *1.8822:1*	75.087 *1.8774:1*	75.05 *1.8726:1*	75.014 *1.8679:1*
148	.... 75.292 *1.9048:1*	75.255 *1.8999:1*	75.219 *1.895:1*	75.183 *1.8902:1*	75.147 *1.8854:1*	75.111 *1.8806:1*
149	.... 75.386 *1.9176:1*	75.35 *1.9127:1*	75.314 *1.9078:1*	75.278 *1.9029:1*	75.242 *1.8981:1*	75.206 *1.8933:1*
150	.... 75.479 *1.9305:1*	75.444 *1.9255:1*	75.408 *1.9206:1*	75.372 *1.9157:1*	75.336 *1.9108:1*	75.301 *1.906:1*
151	.... 75.572 *1.9434:1*	75.536 *1.9384:1*	75.5 *1.9334:1*	75.465 *1.9285:1*	75.429 *1.9236:1*	75.394 *1.9187:1*
152	.... 75.663 *1.9562:1*	75.627 *1.9512:1*	75.592 *1.9462:1*	75.556 *1.9413:1*	75.521 *1.9363:1*	75.486 *1.9314:1*

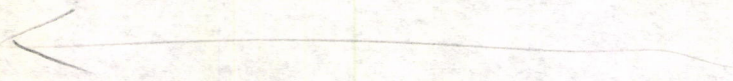
PEAK PISTON SPEED OCCURENCE, DEGREES Before and After TDC
Rod Length-to-Stroke Ratio in Italics

EXAMPLES

FOR

SPD - RPM - FIN GEAR RATIO - WHEEL SIZE

FORMULAS



RIGHT

117 30

GEAR RATIO FORMULAS

PRIMARY GEAR RATIO = $\frac{\text{Primary Driven Gear (input trans shaft gear)}}{\text{Primary Drive Gear (crankshaft gear)}}$

TRANSMISSION RATIO = $\frac{\text{Transmission Driven Gear}}{\text{Transmission Drive Gear}}$

SECONDARY GEAR RATIO = $\frac{\text{Rear Wheel Sprocket}}{\text{Countershaft Sprocket}}$

FINAL GEAR RATIO (overall:1) =

$$\frac{\text{Primary Driven Gear}}{\text{Primary Drive Gear}} \times \frac{\text{Transmission Driven Gear}}{\text{Transmission Drive Gear}} \times \frac{\text{Rear Wheel Sprocket}}{\text{Countershaft Sprocket}}$$

(or)

Primary Gear Ratio x Transmission Ratio x Secondary Gear Ratio

GEAR

Examples

RIGHT

SPEED-RPM-FINAL GEAR RATIO-WHEEL SIZE FORMULAS

$$MPH = \frac{RPM \times R}{G \times 168}$$

$$RPM = \frac{MPH \times G \times 168}{R}$$

$$G = \frac{RPM \times R}{MPH \times 168}$$

$$R = \frac{MPH \times G \times 168}{RPM}$$

168 = constant
MPH = motorcycle speed
RPM = engine speed
G = final gear ratio (overall:1)
R = rear wheel radius (measured in inches & decimal equivalent of fractions from center of axle to surface upon which wheel sets with rider aboard & tire inflated to normal hot operating temperature)

MENTION CORRECTION FACTOR FOR HI-SPEEDS

EXAMPLES

GEAR RATIOS

DISCUSSION

GEAR RATIO CHART

(BLANK WORKSHT PAGE ~~@ BOTTOM~~)

AT TOP ←

- DATE _____
- CUSTOMER _____

SPACE

- YEAR/MFR/MODEL OF ENGINE _____
- ENGINE USEAGE (SPECIFY) _____
- ~~BORE~~ _____ MM
- STROKE _____ MM

SPACE

- PRIMARY DRIVE GEAR TEETH NUMBER
- PRIMARY DRIVEN GEAR TEETH NUMBER
- ~~JACK SHAFT DRIVE~~
- ~~CLUTCH GEAR~~
- TRANSMISSION TOP DRIVE GEAR ~~TEETH~~ NUMBER _____
- TRANSMISSION TOP DRIVEN GEAR TEETH NUMBER _____

CHK ~~PROPER~~ SQUARE

- ☐ COUNTERSHAFT SPROCKET TEETH NUMBER
  OR
- ☐ SPUR DRIVE GEAR TEETH NUMBER
- LIST ALL THAT YOU USE

{ ____, ____, ____, ____, ____, ____, ____,

- ☐ SPUR DRIVEN (& THEN RING/PINION @ BACK

- ☐ ~~REAR WHEEL~~ SPROCKET TEETH NUMBER
  ~~LIST ALL~~

LIST ALL THAT YOU NORMALLY USE

↑ NO TO HAVING SHAFT DRIVE IN WORKSHEET - MAKE SEP. MENTION IN DISCUSSION SECTION AT TOP

RIGHT

3-23-85

MOTOCROSS
WORK SHEET
FILLED OUT

LEFT

ROAD-RACER
WORKSHEET
FILLED OUT

~~34~~
36

RIGHT

35 3T

#11

MOTO-CROSSER PRINTOUT

RPM'S

SECONDARY GEAR RATIO'S	11,000	11,250	11,500	11,750	12,000
31/16	115.3	118.0	120.6	123.2	125.9
30/16	119.5	122.1	(124.9)	127.6	130.3
31/17	122.7	125.5	128.2	131.0	133.9
29/16	123.3	126.1	128.9	131.8	134.6
30/17	126.8	129.7	(132.6)	135.3	138.2
31/18	129.8	132.7	135.7	138.7	141.6
29/17	130.9	133.9	136.9	139.8	142.9
30/18	134.2	137.2	(140.3)	143.4	146.5
29/18	138.8	142.0	145.1	148.2	151.5

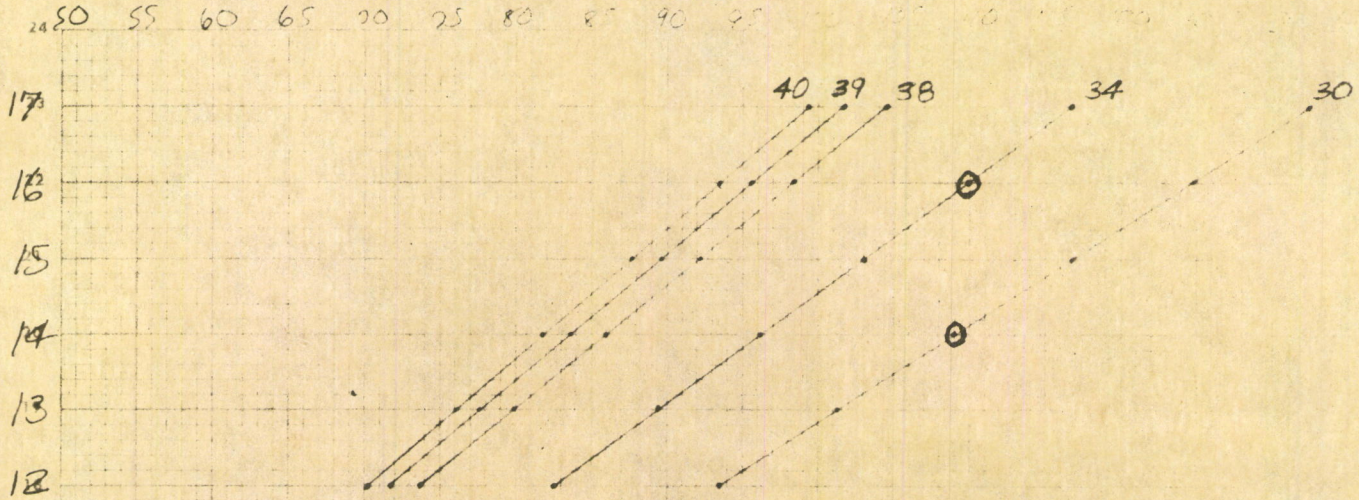
MPH

MPH

LEFT

PAGE #9

ROAD RACER PRINTOUT



WILL GO TO LAGUNA W/ $\frac{34}{17}$:

			$\frac{34}{16}$:
@ 10,900 RPM	=	110.8 MPH	104.2
@ 11,000 RPM	=	111.8 MPH	105.1
@ 11,100 RPM	=	112.8 MPH	106.1
@ 11,200 RPM	=	113.8 MPH	107.0
@ 11,300 RPM	=	114.8 MPH	107.9
@ 11,400 RPM	=	115.8 MPH	108.8
@ 11,500 RPM	=	116.8 MPH	109.9

(LANCE'S TA250 @ 11,250 RPM W/ $\frac{42}{15}$ = 109.4 MPH)

RIGHT

SEE COMPRESSION RATIO PAGES

- NEED PISTON CROWN RADIUS FORMULA

~~- NEED MAXIMUM PEAK PISTON VELOCITY FORMULA~~

~~- NEED PISTON TRAVEL & RPM FOR PISTON SPD FORMULA~~

NEED MPS & MM = RPM

LEFT

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH	10	11	12	13	14	15	16	17
10	1	1.1	1.2	1.3	1.4	1.5	1.6	1.7
11	0.9091	1	1.0909	1.18	1.2727	1.3636	1.4545	1.5
12	0.8333	0.9167	1	1.08	1.1667	1.25	1.3333	1.4
13	0.7692	0.8462	0.9231	1	1.0769	1.1538	1.2308	1.3
14	0.7143	0.7857	0.8571	0.928	1	1.0714	1.1429	1.2
15	0.6667	0.7333	0.8	0.866	0.9333	1	1.0667	1.1
16	0.625	0.6875	0.75	0.812	0.875	0.9375	1	1.06
17	0.5882	0.6471	0.7059	0.764	0.8235	0.8824	0.9412	1
18	0.5556	0.6111	0.6667	0.7222	0.7778	0.8333	0.8889	0.94
19	0.5263	0.5789	0.6316	0.6842	0.7368	0.7895	0.8421	0.8947
20	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85
21	0.4762	0.5238	0.5714	0.619	0.6667	0.7143	0.7619	0.8095
22	0.4545	0.5	0.5455	0.5909	0.6364	0.6818	0.7273	0.7727
23	0.4348	0.4783	0.5217	0.5652	0.6087	0.6522	0.6957	0.7391
24	0.4167	0.4583	0.5	0.5417	0.5833	0.625	0.6667	0.7083
25	0.4	0.44	0.48	0.52	0.56	0.6	0.64	0.68
26	0.3846	0.4231	0.4615	0.5	0.5385	0.5769	0.6154	0.6538
27	0.3704	0.4074	0.4444	0.4815	0.5185	0.5556	0.5926	0.6296
28	0.3571	0.3929	0.4286	0.4643	0.5	0.5357	0.5714	0.6071
29	0.3448	0.3793	0.4138	0.4483	0.4828	0.5172	0.5517	0.5862
30	0.3333	0.3667	0.4	0.4333	0.4667	0.5	0.5333	0.5667
31	0.3226	0.3548	0.3871	0.4194	0.4516	0.4839	0.5161	0.5484
32	0.3125	0.3438	0.375	0.4063	0.4375	0.4688	0.5	0.5313
33	0.303	0.3333	0.3636	0.3939	0.4242	0.4545	0.4848	0.5152
34	0.2941	0.3235	0.3529	0.3824	0.4118	0.4412	0.4706	0.5
35	0.2857	0.3143	0.3429	0.3714	0.4	0.4286	0.4571	0.48
36	0.2778	0.3056	0.3333	0.3611	0.3889	0.4167	0.4444	0.47
37	0.2703	0.2973	0.3243	0.3514	0.3784	0.4054	0.4324	0.45
38	0.2632	0.2895	0.3158	0.3421	0.3684	0.3947	0.4211	0.44
39	0.2564	0.2821	0.3077	0.3333	0.3590	0.3846	0.4103	0.43
40	0.25	0.275	0.3	0.325	0.35	0.375	0.4	0.42
41	0.2439	0.2683	0.2927	0.3171	0.3415	0.3659	0.3902	0.41
42	0.2381	0.2619	0.2857	0.3095	0.3333	0.3571	0.381	0.40
43	0.2326	0.2558	0.2791	0.3023	0.3256	0.3488	0.3721	0.39
44	0.2273	0.25	0.2727	0.2955	0.3182	0.3409	0.3636	0.38
45	0.2222	0.2444	0.2667	0.2889	0.3111	0.3333	0.3556	0.37
46	0.2174	0.2391	0.2609	0.2826	0.3043	0.3261	0.3478	0.36
47	0.2128	0.234	0.2553	0.2766	0.2979	0.3191	0.3404	0.35
48	0.2083	0.2292	0.25	0.2708	0.2917	0.3125	0.3333	0.35
49	0.2041	0.2245	0.2449	0.2653	0.2857	0.3061	0.3265	0.3469
50	0.2	0.22	0.24	0.26	0.28	0.3	0.32	0.34
51	0.1961	0.2157	0.2353	0.2549	0.2745	0.2941	0.3137	0.3333
52	0.1923	0.2115	0.2308	0.25	0.2692	0.2885	0.3077	0.3269
53	0.1887	0.2075	0.2264	0.2453	0.2642	0.283	0.3019	0.3208
54	0.1852	0.2037	0.2222	0.2407	0.2593	0.2778	0.2963	0.3148
55	0.1818	0.2	0.2182	0.2364	0.2545	0.2727	0.2909	0.3091
56	0.1786	0.1964	0.2143	0.2321	0.25	0.2679	0.2857	0.3036
57	0.1754	0.193	0.2105	0.2281	0.2456	0.2632	0.2807	0.2982
58	0.1724	0.1897	0.2069	0.2241	0.2414	0.2586	0.2759	0.2931
59	0.1695	0.1864	0.2034	0.2203	0.2373	0.2542	0.2712	0.2881
60	0.1667	0.1833	0.2	0.2167	0.2333	0.25	0.2667	0.2833
61	0.1639	0.1803	0.1967	0.2131	0.2295	0.2459	0.2623	0.2787
62	0.1613	0.1774	0.1935	0.2097	0.2258	0.2419	0.2581	0.2742
63	0.1587	0.1746	0.1905	0.2063	0.2222	0.2381	0.254	0.2698
64	0.1563	0.1719	0.1875	0.2031	0.2188	0.2344	0.25	0.2656
65	0.1538	0.1692	0.1846	0.2	0.2154	0.2308	0.2462	0.2615
66	0.1515	0.1667	0.1818	0.1970	0.2121	0.2273	0.2424	0.2576
67	0.1493	0.1642	0.1791	0.1940	0.209	0.2239	0.2388	0.2537
68	0.1471	0.1618	0.1765	0.1912	0.2059	0.2206	0.2353	0.25
69	0.1449	0.1594	0.1739	0.1884	0.2029	0.2174	0.2319	0.2464
70	0.1429	0.1571	0.1714	0.1857	0.2	0.2143	0.2286	0.2429
71	0.1408	0.1549	0.169	0.1831	0.1972	0.2113	0.2254	0.2394
72	0.1389	0.1528	0.1667	0.1806	0.1944	0.2083	0.2222	0.2361
73	0.137	0.1507	0.1644	0.1781	0.1918	0.2055	0.2192	0.2329
74	0.1351	0.1486	0.1622	0.1757	0.1892	0.2027	0.2162	0.2297
75	0.1333	0.1467	0.16	0.1733	0.1867	0.2	0.2133	0.2267

A
37

SPROCKET GEAR RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

19	20	21	22	23	24	25
.8	1.9	2	2.1	2	2.3	2.4	2.5
1.6364	1.7273	1.8182	1.909		2.0909	2.1818	2.272
1.5	1.5833	1.6667	1.75	1.8333	1.9167	2	2.083
1.3846	1.4615	1.5385	1.615	1.6923	1.7692	1.8462	1.923
1.2857	1.3571	1.4286	1.5	1.5714	1.6429	1.7143	1.7857
1.2	1.2667	1.3333	1.4	1.4667	1.5333	1.6	1.6667
1.125	1.1875	1.25	1.3125	1.375	1.4375	1.5	1.5625
1.0588	1.1176	1.1765	1.2353	1.2941	1.3529	1.4118	1.4706
1	1.0556	1.1111	1.1667	1.2222	1.2778	1.3333	1.388
0.9474	1	1.0526	1.1053	1.1579	1.2105	1.2632	1.315
0.9	0.95	1	1.05	1.1	1.15	1.2	1.25
0.8571	0.9048	0.9524	1	1.0476	1.0952	1.1429	1.190
0.8182	0.8636	0.9091	0.9545	1	1.0455	1.0909	1.136
0.7826	0.8261	0.8696	0.913	0.9565	1	1.0435	1.087
75	0.7917	0.8333	0.875	0.9167	0.9583	1	1.041
72	0.75	0.8	0.84	88	0.92	0.96	1
6923	0.7308	0.7692	0.807	8462	0.8846	0.9231	0.961
6667	0.7037	0.7407	0.777	8148	0.8519	0.8889	0.925
6429	0.6786	0.7143	0.75	7857	0.8214	0.8571	0.892
6207	0.6552	0.6897	0.724	7586	0.7931	0.8276	0.862
6	0.6333	0.6667	0.7	7333	0.7667	0.8	0.833
5806	0.6129	0.6452	0.677	7097	0.7419	0.7742	0.806
5625	0.5938	0.625	0.656	6875	0.7188	0.75	0.7813
5455	0.5758	0.6061	0.636	6667	0.697	0.7273	0.7576
0.5294	0.5588	0.5882	0.617	0.6471	0.6765	0.7059	0.7353
0.5143	0.5429	0.5714	0.6	0.6286	0.6571	0.6857	0.7143
0.5	0.5278	0.5556	0.5833	0.6111	0.6389	0.6667	0.6944
0.4865	0.5135	0.5405	0.5676	0.5946	0.6216	0.6486	0.6757
0.4737	0.5	0.5263	0.5526	0.5789	0.6053	0.6316	0.6579
0.4615	0.4872	0.5128	0.5385	0.5641	0.5897	0.6154	0.641
0.45	0.475	0.5	0.525	0.55	0.575	0.6	0.625
0.439	0.4634	0.4878	0.5122	0.5366	0.561	0.5854	0.6098
0.4286	0.4524	0.4762	0.5	0.5238	0.5476	0.5714	0.5952
0.4186	0.4419	0.4651	0.4884	0.5116	0.5349	0.5581	0.5814
0.4091	0.4318	0.4545	0.4773	0.5	0.5227	0.5455	0.5682
0.4	0.4222	0.4444	0.4667	0.4889	0.5111	0.5333	0.5556
0.3913	0.413	0.4348	0.4565	0.4783	0.5	0.5217	0.5435
0.383	0.4043	0.4255	0.4468	0.4681	0.4894	0.5106	0.531
0.375	0.3958	0.4167	0.4375	0.4583	0.4792	0.5	0.5208
0.3673	0.3878	0.4082	0.4286	0.449	0.4694	0.4898	0.5102
36	0.38	0.4	0.42	0.44	0.46	0.48	0.5
3529	0.3725	0.3922	0.4118	0.4314	0.451	0.4706	0.4902
3462	0.3654	0.3846	0.4038	0.4231	0.4423	0.4615	0.4808
3396	0.3585	0.3774	0.3962	0.4151	0.434	0.4528	0.4717
3333	0.3519	0.3704	0.3889	0.4074	0.4259	0.4444	0.4630
3273	0.3455	0.3636	0.3818	0.4	0.4182	0.4364	0.4545
3214	0.3393	0.3571	0.375	0.3929	0.4107	0.4286	0.4464
3158	0.3333	0.3509	0.3684	0.386	0.4035	0.4211	0.4386
3103	0.3276	0.3448	0.3621	0.3793	0.3966	0.4138	0.4310
3051	0.322	0.339	0.3559	0.3729	0.3898	0.4068	0.4237
3	0.3167	0.3333	0.35	0.3667	0.3833	0.4	0.4167
0.2951	0.3115	0.3279	0.3443	0.3607	0.377	0.3934	0.4098
0.2903	0.3065	0.3226	0.3387	0.3548	0.371	0.3871	0.4032
0.2857	0.3016	0.3175	0.3333	0.3492	0.3651	0.381	0.3968
0.2813	0.2969	0.3125	0.3281	0.3438	0.3594	0.375	0.3906
0.2769	0.2923	0.3077	0.3231	0.3385	0.3538	0.3692	0.3846
0.2727	0.2879	0.303	0.3182	0.3333	0.3485	0.3636	0.3788
0.2687	0.2836	0.2985	0.3134	0.3284	0.3433	0.3582	0.3731
0.2647	0.2794	0.2941	0.3088	0.3235	0.3382	0.3529	0.3676
0.2609	0.2754	0.2899	0.3043	0.3188	0.3333	0.3478	0.3623
0.2571	0.2714	0.2857	0.3	0.3143	0.3286	0.3429	0.3571
0.2535	0.2676	0.2817	0.2958	0.3099	0.3239	0.338	0.352
0.25	0.2639	0.2778	0.2917	0.3056	0.3194	0.3333	0.347
0.2466	0.2603	0.274	0.2877	0.3014	0.3151	0.3288	0.3425
0.2432	0.2568	0.2703	0.2838	0.2973	0.3108	0.3243	0.337
	0.2533	0.2667	0.5	0.2933	0.3067	0.32	0.333

DRIVE GEAR/SPROCKET TEETH

(CONTINUED ON NEXT PAGE)

(CONTINUED FROM PRECEDING PAGE)

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	27	28			31	32		
	2.6	2.7	2.8		3.1	3.2	3.3	
11	2.3636	2.4545	2.5455	2.6364	2.7273	2.8182	2.9091	3
12	2.1667	2.25	2.3333	2.4167	2.5	2.5833	2.6667	2.75
13	2	2.0769	2.1538	2.2308	2.3077	2.3846	2.4615	2.5385
14	1.8571	1.9286	2	2.0714	2.1429	2.2143	2.2857	2.3571
15	1.7333	1.8	1.8667	1.9333	2	2.0667	2.1333	2.2
16	1.625	1.6875	1.75	1.8125	1.875	1.9375	2	2.0625
17	1.5294	1.5882	1.6471	1.7059	1.7647	1.8235	1.8824	1.9412
18	1.4444	1.5	1.5556	1.6111	1.6667	1.7222	1.7778	1.8333
19	1.3684	1.4211	1.4737	1.5263	1.5789	1.6316	1.6842	1.7368
20	1.3	1.35	1.4	1.45	1.5	1.55	1.6	1.65
21	1.2381	1.2857	1.3333	1.381	1.4286	1.4762	1.5238	1.5714
22	1.1818	1.2273	1.2727	1.3182	1.3636	1.4091	1.4545	1.5
23	1.1304	1.1739	1.2174	1.2608	1.3043	1.3478	1.3913	1.4348
24	1.0833	1.125	1.1667	1.208	1.25	1.2917	1.3333	1.375
25	1.04	1.08	1.12	1.16	1.2	1.24	1.28	1.32
26		1.0385	1.0769	1.115	1.1538	1.1923	1.2308	1.2692
27	1	1	1.037	1.074	1.1111	1.1481	1.1852	1.2222
28	0.9643	0.9643	1	1.035	1.0714	1.1071	1.1429	1.1786
29	0.931	0.931	0.9655	1	1.0345	1.069	1.1034	1.1379
30	0.9	0.9	0.9333	0.966	1	1.0333	1.0667	1.1
31	0.871	0.871	0.9032	0.935	0.9677	1	1.0323	1.0645
32	0.8438	0.8438	0.875	0.906	0.9375	0.9688	1	1.03
33	0.8182	0.8182	0.8485	0.8788	0.9091	0.9394	0.9697	1
34	0.7941	0.7941	0.8235	0.8529	0.8824	0.9118	0.9412	0.9706
35	0.7714	0.7714	0.8	0.8286	0.8571	0.8857	0.9143	0.9429
36	0.75	0.75	0.7778	0.8056	0.8333	0.8611	0.8889	0.9167
37	0.7297	0.7297	0.7568	0.7838	0.8108	0.8378	0.8649	0.8919
38	0.7105	0.7105	0.7368	0.7632	0.7895	0.8158	0.8421	0.8684
39	0.6923	0.6923	0.7179	0.7436	0.7692	0.7949	0.8205	0.8462
40	0.675	0.675	0.7	0.725	0.75	0.775	0.8	0.825
41	0.6585	0.6585	0.6829	0.7073	0.7317	0.7561	0.7805	0.8049
42	0.6429	0.6429	0.6667	0.6905	0.7143	0.7381	0.7619	0.7857
43	0.6279	0.6279	0.6512	0.6744	0.6977	0.7209	0.7442	0.7674
44	0.6136	0.6136	0.6364	0.6591	0.6818	0.7045	0.7273	0.75
45	0.6	0.6	0.6222	0.6444	0.6667	0.6889	0.7111	0.7333
46	0.587	0.587	0.6087	0.6304	0.6522	0.6739	0.6957	0.7174
47	0.5745	0.5745	0.5957	0.617	0.6383	0.6596	0.6809	0.7021
48	0.5625	0.5625	0.5833	0.6042	0.625	0.6458	0.6667	0.6875
49	0.551	0.551	0.5714	0.592	0.6122	0.6327	0.6531	0.6735
50	0.54	0.54	0.56	0.58	0.6	0.62	0.64	0.66
51	0.5294	0.5294	0.549	0.56	0.5882	0.6078	0.6275	0.64
52	0.5192	0.5192	0.5385	0.55	0.5769	0.5962	0.6154	0.634
53	0.5094	0.5094	0.5283	0.54	0.566	0.5849	0.6038	0.622
54	0.5	0.5	0.5185	0.537	0.5556	0.5741	0.5926	0.611
55	0.4909	0.4909	0.5091	0.527	0.5455	0.5636	0.5818	0.6
56	0.4821	0.4821	0.5	0.517	0.5357	0.5536	0.5714	0.589
57	0.4737	0.4737	0.4912	0.508	0.5263	0.5439	0.5614	0.578
58	0.4655	0.4655	0.4828	0.5	0.5172	0.5345	0.5517	0.569
59	0.4576	0.4576	0.4746	0.491	0.5085	0.5254	0.5424	0.5593
60	0.45	0.45	0.4667	0.483	0.5	0.5167	0.5333	0.55
61	0.4426	0.4426	0.459	0.4754	0.4918	0.5082	0.5246	0.541
62	0.4355	0.4355	0.4516	0.4677	0.4839	0.5	0.5161	0.5323
63	0.4286	0.4286	0.4444	0.4603	0.4762	0.4921	0.5079	0.5238
64	0.4219	0.4219	0.4375	0.4531	0.4688	0.4844	0.5	0.5156
65	0.4154	0.4154	0.4308	0.4462	0.4615	0.4769	0.4923	0.5077
66	0.4091	0.4091	0.4242	0.4394	0.4545	0.4697	0.4848	0.5
67	0.403	0.403	0.4179	0.4328	0.4478	0.4627	0.4776	0.4925
68	0.3971	0.3971	0.4118	0.4265	0.4412	0.4559	0.4706	0.4853
69	0.3913	0.3913	0.4058	0.4203	0.4348	0.4493	0.4638	0.4783
70	0.3857	0.3857	0.4	0.4143	0.4286	0.4429	0.4571	0.4714
71	0.3803	0.3803	0.3944	0.4085	0.4225	0.4366	0.4507	0.4648
72	0.375	0.375	0.3889	0.4028	0.4167	0.4306	0.4444	0.4583
73	0.3699	0.3699	0.3836	0.3973	0.411	0.4247	0.4384	0.4521
	0.3649	0.3649	0.3784	0.392	0.4054	0.4189	0.4324	0.4
	0.36	0.36	0.3733	0.3867	0.4	0.4133	0.4267	0.4

RIGHT

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	34	35	36			39	40	41	
	.4	3.5	3.6	3.7	3.8	3.9	4	4.1	
	.0909	3.1818	3.2727	3.3636	3.4545	3.5455	3.6364	3.72	
	.8333	2.9167	3	3.0833	3.1667	3.25	3.3333	3.41	
	.6154	2.6923	2.7692	2.8462	2.9231	3	3.0769	3.15	
	.4286	2.5	2.5714	2.6429	2.7143	2.7857	2.8571	2.92	
	.2667	2.3333	2.4	2.4667	2.5333	2.6	2.6667	2.73	
16	2.125	2.1875	2.25	2.3125	2.375	2.4375	2.5	2.56	
17	2	2.0588	2.1176	2.1765	2.2353	2.2941	2.3529	2.41	
18	1.8889	1.9444	2	2.0556	2.1111	2.1667	2.2222	2.27	
19	1.7895	1.8421	1.8947	1.9474	2	2.0526	2.1053	2.15	
20	1.7	1.75	1.8	1.85	[illegible]	1.95	2	2.05	
21	1.619	1.6667	1.7143	1.761[illegible]	[illegible]8095	1.8571	1.9048	1.9524	
22	1.5455	1.5909	1.6364	1.68[illegible]	[illegible]7273	1.7727	1.8182	1.8636	
23	1.4783	1.5217	1.5652	1.60[illegible]	[illegible]6522	1.6957	1.7391	1.7826	
24	1.4167	1.4583	1.5	1.54	[illegible]5833	1.625	1.6667	1.7083	
25	1.36	1.4	1.44	1.48	[illegible]52	1.56	1.6	1.64	
26	1.3077	1.3462	1.3846	1.42	[illegible]4615	1.5	1.5385	1.5769	
27	1.2593	1.2963	1.3333	1.37	[illegible]4074	1.4444	1.4815	1.5185	
28	1.2143	1.25	1.2857	1.32	[illegible]3571	1.3929	1.4286	1.4643	
29	1.1724	1.2069	1.2414	1.27	[illegible]3103	1.3448	1.3793	1.4138	
30	1.1333	1.1667	1.2	1.23	[illegible]2667	1.3	1.3333	1.3667	
31	1.0968	1.129	1.1613	1.19	[illegible]2258	1.2581	1.2903	1.3226	
32	1.0625	1.0938	1.125	1.15	[illegible]1875	1.2188	1.25	1.2813	
33	1.0303	1.0606	1.0909	1.1212	1.1515	1.1818	1.2121	1.242[illegible]	
34	1	1.0294	1.0588	1.0882	1.1176	1.1471	1.1765	1.205[illegible]	
35	0.9714	1	1.0286	1.0571	1.0857	1.1143	1.1429	1.171[illegible]	
36	0.9444	0.9722	1	1.0278	1.0556	1.0833	1.1111	1.138[illegible]	
37	0.9189	0.9459	0.973	1	1.027	1.0541	1.0811	1.108[illegible]	
38	0.8947	0.9211	0.9474	0.9737	1	1.0263	1.0526	1.078[illegible]	
39	0.8718	0.8974	0.9231	0.9487	0.9744	1	1.0256	1.051[illegible]	
40	0.85	0.875	0.9	0.925	0.95	0.975	1	1.025	
41	0.8293	0.8537	0.878[illegible]	0.9024	0.9268	0.9512	0.9756	1	
42	0.8095	0.8333	0.8571	0.881[illegible]	0.9048	0.9286	0.9524	0.976[illegible]	
[illegible]	[illegible]907	0.814[illegible]	0.8372	0.8605	0.8837	0.907[illegible]	0.9302	0.9535	
[illegible]	[illegible]727	0.7955	0.8182	0.8409	0.8636	0.8864	0.9091	0.9318	
[illegible]	[illegible]556	0.7778	0.8[illegible]	0.8222	0.8444	0.8667	0.8889	0.9111	
[illegible]	[illegible]391	0.7609	0.7826	0.8043	0.8261	0.8478	0.8696	0.8913	
47	0.7234	0.7447	0.766[illegible]	0.7872	0.8085	0.8298	0.8511	0.8723	
48	0.7083	0.7292	0.75[illegible]	0.7708	0.7917	0.8125	0.8333	0.8542	
49	0.6939	0.7143	0.7347	0.755[illegible]	[illegible]755	0.7959	0.8163	0.8367	
50	0.68	0.7	0.72	0.74	[illegible]6	0.78	0.8	0.82	
51	0.6667	0.6863	0.7059	0.725	[illegible]7451	0.7647	0.7843	0.8039	
52	0.6538	0.6731	0.6923	0.711[illegible]	[illegible]7306	0.75[illegible]	0.7692	0.7885	
53	0.6415	0.6604	0.6792	0.698[illegible]	[illegible]717	0.7358	0.7547	0.7736	
54	0.6296	0.6481	0.6667	0.685[illegible]	[illegible]7037	0.7222	0.7407	0.7593	
55	0.6182	0.6364	0.6545	0.672[illegible]	[illegible]6909	0.7091	0.7273	0.7455	
56	0.6071	0.625	0.6429	0.660[illegible]	[illegible]6786	0.6964	0.7143	0.73[illegible]	
[illegible]	[illegible]5965	0.614[illegible]	0.6316	0.649[illegible]	[illegible]6667	0.6842	0.7018	0.719[illegible]	
[illegible]	[illegible]5862	0.6034	0.6207	0.637[illegible]	[illegible]6552	0.6724	0.6897	0.706[illegible]	
[illegible]	[illegible]5763	0.5932	0.6102	0.627[illegible]	[illegible]6441	0.661[illegible]	0.6780	0.694[illegible]	
[illegible]	[illegible]5667	0.5833	0.6[illegible]	0.616[illegible]	[illegible]6333	0.65[illegible]	0.6667	0.6833	0
[illegible]	[illegible]5574	0.5738	0.5902	0.606[illegible]	[illegible]623	0.6393	0.6557	0.6721	0.6
62	0.5484	0.5645	0.5806	0.596[illegible]	[illegible]6129	0.629[illegible]	0.6452	0.6613	0.6
63	0.5397	0.5556	0.5714	0.5873	0.6032	0.619[illegible]	0.6349	0.6508	0.6
64	0.5313	0.5469	0.5625	0.5781	0.5938	0.6094	0.625[illegible]	0.6406	0.6
65	0.5231	0.5385	0.5538	0.5692	0.5846	0.6[illegible]	0.6154	0.6308	0.6
66	0.5152	0.5303	0.5455	0.5606	0.5758	0.5909	0.6061	0.6212	0.6
67	0.5075	0.5224	0.5373	0.5522	0.5672	0.5821	0.597[illegible]	0.6119	0.6
68	0.5	0.5147	0.5294	0.5441	0.5588	0.5735	0.5882	0.6[illegible]	0.6
69	0.4928	0.5072	0.5217	0.5362	0.5507	0.5652	0.5797	0.5[illegible]	0.6
70	0.4857	0.5	0.5143	0.5286	0.5429	0.5571	0.5714	0.5[illegible]	0.5
71	0.4789	0.493[illegible]	0.507[illegible]	0.5211	0.5352	0.5493	0.5634	0.5[illegible]	0.5
72	0.4722	0.4861	0.5	0.5139	0.5278	0.5417	0.5556	0.5[illegible]	0.5
73	[illegible]	0.4795	0.4932	0.5068	0.5205	0.5342	0.5479	0.5[illegible]	0.5
74	[illegible]	0.473[illegible]	0.4865	[illegible]	[illegible]	0.527[illegible]	0.5405	0.5[illegible]	0.5
[illegible]	[illegible]	0.4667	0.48[illegible]	[illegible]	[illegible]	0.52[illegible]	0.5333	0.54[illegible]	0.5

(CONTINUED ON NEXT PAGE)

42
40

LEFT

(CONTINUED FROM PRECEDING PAGE)

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	43	44	45	46	47	48	49	
2	4.3	4.4	4.5	4.6	4.7	4.8	4.[illegible]	
8182	3.9091	4	4.090	1818	4.2727	4.3636	4.454	
5	3.5833	3.6667	3.75	8333	3.9167	4	4.0833	
2308	3.3077	3.3846	3.4615	5385	3.6154	3.6923	3.7692	17
	3.0714	3.1429	3.214	2857	3.3571	3.4286	3.5	14
8	2.8667	2.9333	3	0667	3.1333	3.2	3.2667	15
625	2.6875	2.75	2.812	375	2.9375	3	3.0625	16
4706	2.5294	2.5882	2.647	7059	2.7647	2.8235	2.8824	17
3333	2.3889	2.4444	2.5	6556	2.6111	2.6667	2.7222	18
2105	2.2632	2.3158	2.3684	5211	2.4737	2.5263	2.578	19
1	2.15	2.2	2.25		2.35	2.4	2.4	20
	2.0476	2.0952	2.1429	1905	2.2381	2.2857	2.33	21
	1.9545	2	2.0455	2.0909	2.1364	2.1818	2.22	22
	1.8696	1.913	1.9565	2	2.0435	2.087	2.13	23
	1.7917	1.8333	1.875	1.9167	1.9583	2	2.0417	24
	1.72	1.76	1.8	1.84	1.88	1.92	1.96	25
2564	1.6538	1.6923	1.7308	1.7692	1.8077	1.8462	1.8846	26
1.5556	1.5926	1.6296	1.6667	1.7037	1.7407	1.7778	1.8148	27
1.5	1.5357	1.5714	1.6071	1.6429	1.6786	1.7143	1.75	28
1.4483	1.4828	1.5172	1.5517	1.5862	1.6207	1.6552	1.6897	29
1.4	1.4333	1.4667	1.5	1.5333	1.5667	1.6	1.6333	30
1.3548	1.3871	1.4194	1.4516	1.4839	1.5161	1.5484	1.5806	31
1.3125	1.3438	1.375	1.4063	1.4375	1.4688	1.5	1.5313	32
1.2727	1.303	1.3333	1.3636	1.3939	1.4242	1.4545	1.4848	33
1.2353	1.2647	1.2941	1.3235	1.3529	1.3824	1.4118	1.4412	34
1.2	1.2286	1.2571	1.2857	1.3143	1.3429	1.3714	1.4	35
1667	1.1944	1.2222	1.25	1.2778	1.3056	1.3333	1.3	36
1351	1.1622	1.1892	1.2162	1.2432	1.2703	1.2973	1.3	37
1053	1.1316	1.1579	1.184	2105	1.2368	1.2632	1.2	38
0769	1.1026	1.1282	1.153	1795	1.2051	1.2308	1.2	39
05	1.075	1.1	1.125	15	1.175	1.2	1.22	40
0244	1.0488	1.0732	1.097	122	1.1463	1.1707	1.1951	41
	1.0238	1.0476	1.071	0952	1.119	1.1429	1.1667	42
9767	1	1.0233	1.046	0698	1.093	1.1163	1.1395	43
9545	0.9773	1	1.022	0455	1.0682	1.0909	1.1136	44
9333	0.9556	0.9778	1	0222	1.0444	1.0667	1.0889	45
913	0.9348	0.9565	0.978		1.0217	1.0435	1.0652	46
8936	0.9149	0.9362	0.957	9787	1	1.0213	1.0426	47
875	0.8958	0.9167	0.937	9583	0.9792	1	1.0208	48
0.8571	0.8776	0.898	0.918	9388	0.9592	0.9796	1	49
0.84	0.86	0.88	0.9	0.92	0.94	0.96	0.98	50
0.8235	0.8431	0.8627	0.8824	0.902	0.9216	0.9412	0.9608	51
0.8077	0.8269	0.8462	0.8654	0.8846	0.9038	0.9231	0.9423	52
0.7925	0.8113	0.8302	0.8491	0.8679	0.8868	0.9057	0.924	53
0.7778	0.7963	0.8148	0.8333	0.8519	0.8704	0.8889	0.907	54
0.7636	0.7818	0.8	0.8182	0.8364	0.8545	0.8727	0.89	55
	0.7679	0.7857	0.8036	0.8214	0.8393	0.8571	0.87	56
66	0.7544	0.7719	0.7895	0.807	0.8246	0.8421	0.85	57
41	0.7414	0.7586	0.7759	0.7931	0.8103	0.8276	0.8448	58
19	0.7288	0.7458	0.7627	0.7797	0.7966	0.8136	0.8305	59
	0.7167	0.7333	0.75	0.7667	0.7833	0.8	0.8167	60
0.7	0.7049	0.7213	0.7377	0.7541	0.7705	0.7869	0.8033	61
0.6885	0.6935	0.7097	0.7258	0.7419	0.7581	0.7742	0.7903	62
0.6774	0.6825	0.6984	0.7143	0.7302	0.746	0.7619	0.7778	63
0.6667	0.6719	0.6875	0.7031	0.7188	0.7344	0.75	0.7656	64
0.6563	0.6615	0.6769	0.6923	0.7077	0.7231	0.7385	0.7538	65
0.6462	0.6515	0.6667	0.6818	0.697	0.7121	0.7273	0.7424	66
0.6364	0.6418	0.6567	0.6716	0.6866	0.7015	0.7164	0.7313	67
0.6269	0.6324	0.6471	0.6618	0.6765	0.6912	0.7059	0.7206	68
0.6176	0.6232	0.6377	0.6522	0.6667	0.6812	0.6957	0.7101	69
0.6087	0.6143	0.6286	0.6429	0.6571	0.6714	0.6857	0.7	70
0.6	0.6056	0.6197	0.6338	0.6479	0.662	0.6761	0.6901	71
0.5915	0.5972	0.6111	0.625	0.6389	0.6528	0.6667	0.6806	72
0.5833	0.589	0.602		01	0.6438	0.6575	0.67	
0.5753	0.5811	0.594		16	0.6351	0.6486	0.6	
5676	0.5733	0.58		33	0.6267	0.64	0	

GEAR/SPROCKET RATIO CHART

RIGHT

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	51	52	53	54	55	56	57	
	5.1	5.2	5.3	4	5.5	5.6	5.7	
	4.5455	4.6364	4.7273	4.81	9091	5	5.0909	5.1818
	4.1667	4.25	4.3333	4.41	5	4.5833	4.6667	4.75
13	3.8462	3.9231	4	4.07	1538	4.2308	4.3077	4.3846
14	3.5714	3.6429	3.7143	3.78	8571	3.9286	4	4.0714
15	3.3333	3.4	3.4667	3.53	6	3.6667	3.7333	3.8
16	3.125	3.1875	3.25	3.31	375	3.4375	3.5	3.5625
17	2.9412	3	3.0588	3.11	1765	3.2353	3.2941	3.3529
18	2.7778	2.8333	2.8889	2.9444	3	3.0556	3.1111	3.1667
19	2.6316	2.6842	2.7368	2.7895	2.8421	2.8947	2.9474	3
20	2.5	2.55	2.6	2.65	2.7	2.75	2.8	2.85
21	2.381	2.4286	2.4762	2.5238	2.5714	2.619	2.6667	2.7143
22	2.2727	2.3182	2.3636	2.4091	2.4545	2.5	2.5455	2.5909
23	2.1739	2.2174	2.2609	2.3043	2.3478	2.3913	2.4348	2.4783
24	2.0833	2.125	2.1667	2.2083	2.25	2.2917	2.3333	2.375
25		2.04	2.08	2.12	2.16	2.2	2.24	2.28
	1.9231	1.9615	2	2.0385	2.0769	2.1154	2.1538	2.1
	1.8519	1.8889	1.9259	1.963	2	2.037	2.0741	2.1
	1.7857	1.8214	1.8571	1.8929	1.9286	1.9643	2	2.0
	1.7241	1.7586	1.7931	1.8276	1.8621	1.8966	1.931	1.9
30	1.6667	1.7	1.7333	1.7667	1.8	1.8333	1.8667	1.9
31	1.6129	1.6452	1.6774	1.7097	1.7419	1.7742	1.8065	1.8387
32	1.5625	1.5938	1.625	1.6563	1.6875	1.7188	1.75	1.7813
33	1.5152	1.5455	1.5758	1.606	6364	1.6667	1.697	1.7273
34	1.4706	1.5	1.5294	1.55	5882	1.6176	1.6471	1.6765
35	1.4286	1.4571	1.4857	1.51	5429	1.5714	1.6	1.6286
36	1.3889	1.4167	1.4444	1.47	5	1.5278	1.5556	1.5833
37	1.3514	1.3784	1.4054	1.43	4595	1.4865	1.5135	1.5405
38	1.3158	1.3421	1.3684	1.39	4211	1.4474	1.4737	1.5
39	1.2821	1.3077	1.3333	1.35	3846	1.4103	1.4359	1.4615
40	1.25	1.275	1.3	1.32	35	1.375	1.4	1.425
41	1.2195	1.2439	1.2683	1.29	3171	1.3415	1.3659	1.3902
42	1.1905	1.2143	1.2381	1.26	2857	1.3095	1.3333	1.3571
	1.1628	1.186	1.2093	1.23	2558	1.2791	1.3023	1.3256
	1.1364	1.1591	1.1818	1.2045	1.2273	1.25	1.2727	1.2955
	1.1111	1.1333	1.1556	1.1778	1.2	1.2222	1.2444	1.2667
	1.087	1.1087	1.1304	1.1522	1.1739	1.1957	1.2174	1.2391
	1.0638	1.0851	1.1064	1.1277	1.1489	1.1702	1.1915	1.2128
48	1.0417	1.0625	1.0833	1.1042	1.125	1.1458	1.1667	1.1875
49	1.0204	1.0408	1.0612	1.0816	1.102	1.1224	1.1429	1.163
50	1	1.02	1.04	1.06	1.08	1.1	1.12	1.14
51	0.9804	1	1.0196	1.0392	1.0588	1.0784	1.098	1.117
52	0.9615	0.9808	1	1.0192	1.0385	1.0577	1.0769	1.096
53	0.9434	0.9623	0.9811	1	1.0189	1.0377	1.0566	1.0755
54	0.9259	0.9444	0.963	0.9815	1	1.0185	1.037	1.0556
55	0.9091	0.9273	0.9455	0.9636	0.9818	1	1.0182	1.0364
56	0.8929	0.9107	0.9286	0.9464	0.9643	0.9821	1	1.0179
57	0.8772	0.8947	0.9123	0.9298	0.9474	0.9649	0.9825	1
58	0.8621	0.8793	0.8966	0.9138	0.931	0.9483	0.9655	0.9828
59	0.8475	0.8644	0.8814	0.8983	0.9153	0.9322	0.9492	0.9661
60	0.8333	0.85	0.8667	0.8833	0.9	0.9167	0.9333	0.95
61	0.8197	0.8361	0.8525	0.8689	0.8852	0.9016	0.918	0.9344
62	0.8065	0.8226	0.8387	0.8548	0.871	0.8871	0.9032	0.9194
63	0.7937	0.8095	0.8254	0.8413	0.8571	0.873	0.8889	0.9048
64	0.7813	0.7969	0.8125	0.8281	0.8438	0.8594	0.875	0.8906
65	0.7692	0.7846	0.8	0.8154	0.8308	0.8462	0.8615	0.8769
66	0.7576	0.7727	0.7879	0.803	0.8182	0.8333	0.8485	0.8636
67	0.7463	0.7612	0.7761	0.79	806	0.8209	0.8358	0.8507
68	0.7353	0.75	0.7647	0.77	7941	0.8088	0.8235	0.8382
69	0.7246	0.7391	0.7536	0.76	7826	0.7971	0.8116	0.8261
70	0.7143	0.7286	0.7429	0.75	7714	0.7857	0.8	0.8143
	0.7042	0.7183	0.7324	0.74	7606	0.7746	0.7887	0.8028
	0.6944	0.7083	0.7222	0.73	75	0.7639	0.7778	0.7917
	0.6849	0.6986	0.7123	0.72	7397	0.7534	0.7671	0.7808
	0.6757	0.6892	0.7027	0.71	7297	0.7432	0.7568	0.
	0.6667	0.68	0.6933	0.70	72	0.7333	0.7467	0.

(CONTINUED ON NEXT PAGE)

44
42

(CONTINUED FROM PRECEDING PAGE)

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	59	60	61	62	63	64	
8	5.9	6	6.1	6.2	6.3	6.4	6.5
12	5.2727	5.3636	5.4545	5.5454	5.6364	5.7273	5.8182	5.9091
13	4.8333	4.9167	5	5.0833	5.1667	5.25	5.3333	5.4167
14	4.4615	4.5385	4.6154	4.6923	4.7692	4.8462	4.9231	5
15	4.1429	4.2143	4.2857	4.3571	4.4286	4.5	4.5714	4.6429
16	3.8667	3.9333	4	4.0667	4.1333	4.2	4.2667	4.3333
17	3.625	3.6875	3.75	3.8125	3.875	3.9375	4	4.0625
18	3.4118	3.4706	3.5294	3.5882	3.6471	3.7059	3.7647	3.8235
19	3.2222	3.2778	3.3333	3.3889	3.4444	3.5	3.5556	3.6111
20	3.0526	3.1053	3.1579	3.2105	3.2632	3.3158	3.3684	3.4211
21	2.9	2.95	3	3.05	3.1	3.15	3.2	3.25
22	2.7619	2.8095	2.8571	2.9048	2.9524	3	3.0476	3.0952
23	2.6364	2.6818	2.7273	2.7727	2.8182	2.8636	2.9091	2.9545
24	2.5217	2.5652	2.6087	2.6522	2.6957	2.7391	2.7826	2.8261
25	2.4167	2.4583	2.5	2.5417	2.5833	2.625	2.6667	2.7083
26	2.32	2.36	2.4	2.44	2.48	2.52	2.56	2.6
27	2.2308	2.2692	2.3077	2.3462	2.3846	2.4231	2.4615	2.5
28	2.1481	2.1852	2.2222	2.2593	2.2963	2.3333	2.3704	2.4074
29	2.0714	2.1071	2.1429	2.1786	2.2143	2.25	2.2857	2.3214
30	2	2.0345	2.069	2.1034	2.1379	2.1724	2.2069	2.2414
31	1.9333	1.9667	2	2.0333	2.0667	2.1	2.1333	2.1667
32	1.871	1.9032	1.9355	1.9677	2	2.0323	2.0645	2.0968
33	1.8125	1.8438	1.875	1.9062	1.9375	1.9688	2	2.0313
34	1.7576	1.7879	1.8182	1.8485	1.8788	1.9091	1.9394	1.9697
35	1.7059	1.7353	1.7647	1.7941	1.8235	1.8529	1.8824	1.9118
36	1.6571	1.6857	1.7143	1.7429	1.7714	1.8	1.8286	1.8571
37	1.6111	1.6389	1.6667	1.6944	1.7222	1.75	1.7778	1.8056
38	1.5676	1.5946	1.6216	1.6486	1.6757	1.7027	1.7297	1.7568
39	1.5263	1.5526	1.5789	1.6053	1.6316	1.6579	1.6842	1.7105
40	1.4872	1.5128	1.5385	1.5641	1.5897	1.6154	1.641	1.6667
41	1.45	1.475	1.5	1.525	1.55	1.575	1.6	1.625
42	1.4146	1.439	1.4634	1.4878	1.5122	1.5366	1.561	1.585
43	1.381	1.4048	1.4286	1.4524	1.4762	1.5	1.5238	1.54
44	1.3488	1.3721	1.3953	1.4186	1.4419	1.4651	1.4884	1.5116
45	1.3182	1.3409	1.3636	1.3864	1.4091	1.4318	1.4545	1.4773
46	1.2889	1.3111	1.3333	1.3556	1.3778	1.4	1.4222	1.4444
47	1.2609	1.2826	1.3043	1.3261	1.3478	1.3696	1.3913	1.413
48	1.234	1.2553	1.2766	1.2979	1.3191	1.3404	1.3617	1.383
49	1.2083	1.2292	1.25	1.2708	1.2917	1.3125	1.3333	1.3542
50	1.1837	1.2041	1.2245	1.2449	1.2653	1.2857	1.3061	1.3265
51	1.16	1.18	1.2	1.22	1.24	1.26	1.28	1.3
52	1.1373	1.1569	1.1765	1.1961	1.2157	1.2353	1.2549	1.2745
53	1.1154	1.1346	1.1538	1.1731	1.1923	1.2115	1.2308	1.25
54	1.0943	1.1132	1.1321	1.1509	1.1698	1.1887	1.2075	1.2264
55	1.0741	1.0926	1.1111	1.1296	1.1481	1.1667	1.1852	1.2037
56	1.0545	1.0727	1.0909	1.1091	1.1273	1.1455	1.1636	1.1818
57	1.0357	1.0536	1.0714	1.0893	1.1071	1.125	1.1429	1.160
58	1.0175	1.0351	1.0526	1.0702	1.0877	1.1053	1.1228	1.14
59	1	1.0172	1.0345	1.0517	1.069	1.0862	1.1034	1.12
60	0.9831	1	1.0169	1.0339	1.0508	1.0678	1.0847	1.101
61	0.9667	0.9833	1	1.0167	1.0333	1.05	1.0667	1.0833
62	0.9508	0.9672	0.9836	1	1.0164	1.0328	1.0492	1.0656
63	0.9355	0.9516	0.9677	0.9839	1	1.0161	1.0323	1.0484
64	0.9206	0.9365	0.9524	0.9683	0.9841	1	1.0159	1.0317
65	0.9063	0.9219	0.9375	0.9531	0.9688	0.9844	1	1.0156
66	0.8923	0.9077	0.9231	0.9385	0.9538	0.9692	0.9846	1
67	0.8788	0.8939	0.9091	0.9242	0.9394	0.9545	0.9697	0.9848
68	0.8657	0.8806	0.8955	0.9104	0.9254	0.9403	0.9552	0.9701
69	0.8529	0.8676	0.8824	0.8971	0.9118	0.9265	0.9412	0.9559
70	0.8406	0.8551	0.8696	0.884	0.8986	0.913	0.9275	0.942
71	0.8286	0.8429	0.8571	0.8714	0.8857	0.9	0.9143	0.9286
72	0.8169	0.831	0.8451	0.8592	0.8732	0.8873	0.9014	0.9155
73	0.8056	0.8194	0.8333	0.8472	0.8611	0.875	0.8889	0.9028
74	0.7945	0.8082	0.8219	0.8356	0.8493	0.863	0.8767	0.8904
75	0.7838	0.7973	0.8108	0.8243	0.8378	0.8514	0.8649	0.8
76	0.7733	0.7867	0.8	0.8133	0.8267	0.84	0.8533	0.

Right

Gear/Sprocket Ratio Chart

Driven Gear/Sprocket Teeth

Drive Gear/Sprocket Teeth

66	67	68	69	70	71	72	73
					7.1	7.2	7.3
6.6	6.7	6.8	6.9				
	6.0909	6.1818	6.27	3636	6.4545	6.5455	6.6364
6				8333	5.9167	6	6.0833
5.5	5.5833	5.6667	5.75				
5.0769	5.1538	5.2308	5.30	3846	5.4615	5.5385	5.6154
4.7143	4.7857	4.8571	4.92		5.0714	5.1429	5.2143
4.4	4.4667	4.5333	4.6	6667	4.7333	4.8	4.8667
4.125	4.1875	4.25	4.31	375	4.4375	4.5	4.5625
3.8824	3.9412	4	4.0588	4.1176	4.1765	4.2353	4.2941
3.6667	3.7222	3.7778	3.8333	3.8889	3.9444	4	4.0556
3.4737	3.5263	3.5789	3.6316	3.6842	3.7368	3.7895	3.8421
3.3	3.35	3.4	3.45	3.5	3.55	3.6	3.65
3.1429	3.1905	3.2381	3.2857	3.3333	3.381	3.4286	3.4762
	3.0455	3.0909	3.1364	3.1818	3.2273	3.2727	3.3182
96	2.913	2.9565	3	.0435	3.087	3.1304	3.1739
	2.7917	2.8333	2.87	.9167	2.9583	3	3.0417
	2.68	2.72	2.76	8	2.84	2.88	2.92
5385	2.5769	2.6154	2.65	6923	2.7308	2.7692	2.8077
2.4444	2.4815	2.5185	2.55	5926	2.6296	2.6667	2.7037
2.3571	2.3929	2.4286	2.46	5	2.5357	2.5714	2.6071
2.2759	2.3103	2.3448	2.37	4138	2.4483	2.4828	2.517
2.2	2.2333	2.2667	2.3	3333	2.3667	2.4	2.433
2.129	2.1613	2.1935	2.225	2581	2.2903	2.3226	2.354
2.0625	2.0938	2.125	2.156	1875	2.2188	2.25	2.2813
2	2.0303	2.0606	2.0909	2.1212	2.1515	2.1818	2.2121
1.9412	1.9706	2	2.0294	2.0588	2.0882	2.1176	2.1471
1.8857	1.9143	1.9429	1.9714	2	2.0286	2.0571	2.0857
1.8333	1.8611	1.8889	1.9167	1.9444	1.9722	2	2.0278
1.7838	1.8108	1.8378	1.8649	1.8919	1.9189	1.9459	1.973
1.7368	1.7632	1.7895	1.8158	1.8421	1.8684	1.8947	1.9211
1.6923	1.7179	1.7436	1.7692	1.7949	1.8205	1.8462	1.8718
1.65	1.675	1.7	1.725	1.75	1.775	1.8	1.825
1.[illegible]98	1.6341	1.6585	1.6829	1.7073	1.7317	1.7561	1.7805
[illegible]4	1.5952	1.619	1.6429	1.6667	1.6905	1.7143	1.7381
[illegible]3	1.5581	1.5814	1.6047	1.6279	1.6512	1.6744	1.6977
	1.5227	1.5455	1.5682	1.5909	1.6136	1.6364	1.6591
667	1.4889	1.5111	1.5333	1.5556	1.5778	1.6	1.6222
4348	1.4565	1.4783	1.5	1.5217	1.5435	1.5652	1.587
1.4043	1.4255	1.4468	1.46	4894	1.5106	1.5319	1.5532
1.375	1.3958	1.4167	1.43	4583	1.4792	1.5	1.5208
1.3469	1.3673	1.3878	1.40	4286	1.449	1.4694	1.4898
1.32	1.34	1.36	1.38	4	1.42	1.44	1.46
1.2941	1.3137	1.3333	1.352	3725	1.3922	1.4118	1.4314
1.2692	1.2885	1.3077	1.326	3462	1.3654	1.3846	1.4037
1.2453	1.2642	1.283	1.301	3208	1.3396	1.3585	1.377
1.2222	1.2407	1.2593	1.277	2963	1.3148	1.3333	1.351
1.2	1.2182	1.2364	1.2545	1.2727	1.2909	1.3091	1.3273
1.1786	1.1964	1.2143	1.2321	1.25	1.2679	1.2857	1.3036
1.1579	1.1754	1.193	1.2105	1.2281	1.2456	1.2632	1.2807
1.1379	1.1552	1.1724	1.1897	1.2069	1.2241	1.2414	1.2586
1.1186	1.1356	1.1525	1.1695	1.1864	1.2034	1.2203	1.2373
1.1	1.1167	1.1333	1.15	1.1667	1.1833	1.2	1.2167
1.082	1.0984	1.1148	1.1311	1.1475	1.1639	1.1803	1.1967
1.0645	1.0806	1.0968	1.1129	1.129	1.1452	1.1613	1.1774
1.0476	1.0635	1.0794	1.0952	1.1111	1.127	1.1429	1.1587
1.0313	1.0469	1.0625	1.0781	1.0938	1.1094	1.125	1.1406
1.0154	1.0308	1.0462	1.0615	1.0769	1.0923	1.1077	1.1231
1	1.0152	1.0303	1.0455	1.0606	1.0758	1.0909	1.1061
0.9851	1	1.0149	1.0299	1.0448	1.0597	1.0746	1.0896
0.9706	0.9853	1	1.0147	1.0294	1.0441	1.0588	1.0735
0.9565	0.971	0.9855	1	1.0145	1.029	1.0435	1.058
0.9429	0.9571	0.9714	0.98		1.0143	1.0286	1.0429
0.9296	0.9437	0.9577	0.97	9859	1	1.0141	1.0282
0.9167	0.9306	0.9444	0.95	9722	0.9861	1	1.0139
0.9041	0.9178	0.9315	0.94	.9589	0.9726	0.9863	1
719	0.9054	0.9189	0.93	.9459	0.9595	0.973	0.98
	0.8933	0.9067	0.9	.9333	0.9467	0.96	0.97

(continued on following page)

46
44

(CONTINUED FROM PRECEDING PAGE)

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	75	76	77	78	79	80	
	7.5	7.6	7.7	7.8	7.9	8	8.1
	6.7273	6.6182	6.9091	7	7.1818	7.2727	7.3636
	6.1667	6.25	6.3333	6.416	6.5833	6.6667	6.75
	5.6923	5.7692	5.8462	5.923	6.0769	6.1538	6.2308
	5.2857	5.3571	5.4286	5.5	5.6429	5.7143	5.7857
	4.9333	5	5.0667	5.133	5.2667	5.3333	5.4
	4.625	4.6875	4.75	4.8125	4.875	4.9375	5
	4.3529	4.4118	4.4706	4.5294	4.5882	4.6471	4.7059
	4.1111	4.1667	4.2222	4.2778	4.3333	4.3889	4.4444
	3.8947	3.9474	4	4.0526	4.1053	4.1579	4.2105
	3.7	3.75	3.8	3.85	3.9	3.95	4
	3.5238	3.5714	3.619	3.6667	3.7143	3.7619	3.8095
	3.3636	3.4091	3.4545	3.5	3.5455	3.5909	3.6364
	3.2174	3.2609	3.3043	3.3478	3.3913	3.4348	3.4783
	3.0833	3.125	3.1667	3.2083	3.25	3.2917	3.3333
	3	3	3.04	3.08	3.12	3.16	3.2
	2.8462	2.8846	2.9231	2.9615	3	3.0385	3.0769
	2.7407	2.7778	2.8148	2.851	2.889	2.9259	2.963
	2.6429	2.6786	2.7143	2.75	2.7857	2.8214	2.8571
	2.5517	2.5862	2.6207	2.655	2.6897	2.7241	2.7586
	2.4667	2.5	2.5333	2.566	2.6	2.6333	2.6667
	2.3871	2.4194	2.4516	2.483	2.5161	2.5484	2.5806
	2.3125	2.3438	2.375	2.406	2.4375	2.4688	2.5
	2.2424	2.2727	2.303	2.333	2.3636	2.3939	2.4242
	2.1765	2.2059	2.2353	2.264	2.2941	2.3235	2.3529
	2.1143	2.1429	2.1714	2.2	2.2286	2.2571	2.2857
	2.0556	2.0833	2.1111	2.138	2.1667	2.1944	2.2222
	2	2.027	2.0541	2.0811	2.1081	2.1351	2.1622
	1.9474	1.9737	2	2.0263	2.0526	2.0789	2.1053
	1.8974	1.9231	1.9487	1.9744	2	2.0256	2.0513
	1.85	1.875	1.9	1.925	1.95	1.975	2
	1.8049	1.8293	1.8537	1.878	1.9024	1.9268	1.9512
	1.7619	1.7857	1.8095	1.8333	1.8571	1.881	1.9048
	1.7209	1.7442	1.7674	1.7907	1.814	1.8372	1.8605
	1.6818	1.7045	1.7273	1.75	1.7727	1.7955	1.8182
	1.6444	1.6667	1.6889	1.7111	1.7333	1.7556	1.7778
	1.6087	1.6304	1.6522	1.6739	1.6957	1.7174	1.7391
	1.5745	1.5957	1.617	1.6383	1.6596	1.6809	1.7021
	1.5417	1.5625	1.5833	1.604	1.625	1.6458	1.6667
	1.5102	1.5306	1.551	1.571	1.5918	1.6122	1.6327
	1.48	1.5	1.52	1.54	1.56	1.58	1.6
	1.451	1.4706	1.4902	1.509	1.5294	1.549	1.5686
	1.4231	1.4423	1.4615	1.48	1.5	1.5192	1.5385
	1.3962	1.4151	1.434	1.453	1.4717	1.4906	1.5094
	1.3704	1.3889	1.4074	1.426	1.4444	1.463	1.4815
	1.3455	1.3636	1.3818	1.4	1.4182	1.4364	1.4545
	1.3214	1.3393	1.3571	1.375	1.3929	1.4107	1.4286
	1.2982	1.3158	1.3333	1.3509	1.3684	1.386	1.4035
	1.2759	1.2931	1.3103	1.3276	1.3448	1.3621	1.3793
	1.2542	1.2712	1.2881	1.3051	1.322	1.339	1.3559
	1.2333	1.25	1.2667	1.2833	1.3	1.3167	1.3333
	1.2131	1.2295	1.2459	1.2623	1.2787	1.2951	1.3115
	1.1935	1.2097	1.2258	1.2419	1.2581	1.2742	1.2903
	1.1746	1.1905	1.2063	1.2222	1.2381	1.254	1.2698
	1.1563	1.1719	1.1875	1.2031	1.2188	1.2344	1.25
	1.1385	1.1538	1.1692	1.1846	1.2	1.2154	1.2308
	1.1212	1.1364	1.1515	1.1667	1.1818	1.197	1.2121
	1.1045	1.1194	1.1343	1.1492	1.1642	1.1791	1.194
	1.0882	1.1029	1.1176	1.1324	1.1471	1.1618	1.1765
	1.0725	1.087	1.1014	1.1159	1.1304	1.1449	1.1594
	1.0571	1.0714	1.0857	1.1	1.1143	1.1286	1.1429
	1.0423	1.0563	1.0704	1.0845	1.0986	1.1127	1.1268
	1.0278	1.0417	1.0556	1.0694	1.0833	1.0972	1.1111
	1.0137	1.0274	1.0411	1.0548	1.0685	1.0822	1.0959
		1.0135	1.027	1.0405	1.0541	1.0676	1.0811
		1	1.0133	1.0266	1.04	1.0533	1.0667

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	83	84	85	86	87	88	89	
	8.3	8.4	8.5	8.6	8.7	8.8	8.9	
12	7.4545	7.5455	7.6364	7.72	7.8182	7.9091	8	8.0909
13	6.8333	6.9167	7	7.08	7.1667	7.25	7.3333	7.4167
14	6.3077	6.3846	6.4615	6.53	6.6154	6.6923	6.7692	6.8462
15	5.8571	5.9286	6	6.07	6.1429	6.2143	6.2857	6.3571
16	5.4667	5.5333	5.6	5.666	5.7333	5.8	5.8667	5.9333
17	5.125	5.1875	5.25	5.3125	5.375	5.4375	5.5	5.5625
18	4.8235	4.8824	4.9412	5	5.0588	5.1176	5.1765	5.2353
19	4.5556	4.6111	4.6667	4.7222	4.7778	4.8333	4.8889	4.9444
20	4.3158	4.3684	4.4211	4.4737	4.5263	4.5789	4.6316	4.6842
21	4.1	4.15	4.2	4.25	4.3	4.35	4.4	4.45
22	3.9048	3.9524	4	4.0476	4.0952	4.1429	4.1905	4.2381
23	3.7273	3.7727	3.8182	3.8636	3.9091	3.9545	4	4.0455
24	3.5652	3.6087	3.6522	3.6957	3.7391	3.7826	3.8261	3.8696
25	3.417	3.4583	3.5	3.5417	3.5833	3.625	3.6667	3.7083
26	3.28	3.32	3.36	3.4	3.44	3.48	3.52	3.56
27	3.1538	3.1923	3.2308	3.269	3.3077	3.3462	3.3846	3.4231
28	3.037	3.0741	3.1111	3.14	3.1852	3.2222	3.2593	3.296
29	2.9286	2.9643	3	3.03	3.0714	3.1071	3.1429	3.178
30	2.8276	2.8621	2.8966	2.93	2.9655	3	3.0345	3.069
31	2.7333	2.7667	2.8	2.83	2.8667	2.9	2.9333	2.9667
32	2.6452	2.6774	2.7097	2.74	2.7742	2.8065	2.8387	2.871
33	2.5625	2.5938	2.625	2.65	2.6875	2.7188	2.75	2.7813
34	2.4848	2.5152	2.5455	2.57	2.6061	2.6364	2.6667	2.697
35	2.4118	2.4412	2.4706	2.5	2.5294	2.5588	2.5882	2.6176
36	2.3429	2.3714	2.4	2.4286	2.4571	2.4857	2.5143	2.5429
37	2.2778	2.3056	2.3333	2.3611	2.3889	2.4167	2.4444	2.4722
38	2.2162	2.2432	2.2703	2.2973	2.3243	2.3514	2.3784	2.4054
39	2.1579	2.1842	2.2105	2.2368	2.2632	2.2895	2.3158	2.3421
40	2.1026	2.1282	2.1538	2.1795	2.2051	2.2308	2.2564	2.2821
41	2.05	2.075	2.1	2.125	2.15	2.175	2.2	2.225
42	2	2.0244	2.0488	2.0732	2.0976	2.122	2.1463	2.1707
43	1.9524	1.9762	2	2.0238	2.0476	2.0714	2.0952	2.119
44	1.907	1.9302	1.9535	1.9767	2	2.0233	2.0465	2.0698
45	1.8636	1.8864	1.9091	1.9318	1.9545	1.9773	2	2.0227
46	1.8222	1.8444	1.8667	1.8889	1.9111	1.9333	1.9556	1.9778
47	1.7826	1.8043	1.8261	1.8478	1.8696	1.8913	1.913	1.9348
48	1.7447	1.766	1.7872	1.8085	1.8298	1.8511	1.8723	1.8936
49	1.7083	1.7292	1.75	1.7708	1.7917	1.8125	1.8333	1.8542
50	1.6735	1.6939	1.7143	1.7347	1.7551	1.7755	1.7959	1.816
51	1.64	1.66	1.68	1.7	1.72	1.74	1.76	1.78
52	1.6078	1.6275	1.6471	1.66	1.6863	1.7059	1.7255	1.7451
53	1.5769	1.5962	1.6154	1.63	1.6538	1.6731	1.6923	1.7115
54	1.5472	1.566	1.5849	1.60	1.6226	1.6415	1.6604	1.6792
55	1.5185	1.537	1.5556	1.57	1.5926	1.6111	1.6296	1.6481
56	1.4909	1.5091	1.5273	1.54	1.5636	1.5818	1.6	1.6182
57	1.4643	1.4821	1.5	1.51	1.5357	1.5536	1.5714	1.5893
58	1.4386	1.4561	1.4737	1.49	1.5088	1.5263	1.5439	1.5614
59	1.4138	1.431	1.4483	1.46	1.4828	1.5	1.5172	1.5345
60	1.3898	1.4068	1.4237	1.440	1.4576	1.4746	1.4915	1.5085
61	1.3667	1.3833	1.4	1.4167	1.4333	1.45	1.4667	1.4833
62	1.3443	1.3607	1.377	1.3934	1.4098	1.4262	1.4426	1.459
63	1.3226	1.3387	1.3548	1.371	1.3871	1.4032	1.4194	1.4355
64	1.3016	1.3175	1.3333	1.3492	1.3651	1.381	1.3968	1.4127
65	1.2813	1.2969	1.3125	1.3281	1.3438	1.3594	1.375	1.3906
66	1.2615	1.2769	1.2923	1.3077	1.3231	1.3385	1.3538	1.3692
67	1.2424	1.2576	1.2727	1.2879	1.303	1.3182	1.3333	1.3485
68	1.2239	1.2388	1.2537	1.2687	1.2836	1.2985	1.3134	1.3284
69	1.2059	1.2206	1.2353	1.25	1.2647	1.2794	1.2941	1.3088
70	1.1884	1.2029	1.2174	1.232	1.2464	1.2609	1.2754	1.2899
71	1.1714	1.1857	1.2	1.214	1.2286	1.2429	1.2571	1.2714
72	1.1549	1.169	1.1831	1.197	1.2113	1.2254	1.2394	1.2535
73	1.1389	1.1528	1.1667	1.180	1.1944	1.2083	1.2222	1.2361
74	1.1233	1.137	1.1507	1.164	1.1781	1.1918	1.2055	1.2192
75	1.1081	1.1216	1.1351	1.148	1.1622	1.1757	1.1892	1.202
76	1.0933	1.1067	1.12	1.13	1.1467	1.16	1.1733	1.1

(CONTINUED ON NEXT PAGE)

GEAR/SPROCKET RATIO CHART

DRIVEN GEAR/SPROCKET TEETH

DRIVE GEAR/SPROCKET TEETH

	91	92	93	94	95	96	97	
	9.1	9.2	9.3	9.4	9.5	9.6	9.7	
12	8.1818	8.2727	8.3636	8.454	8.5455	8.6364	8.7273	8.816	
12	7.5	7.5833	7.6667	7.75	7.8333	7.9167	8	8.0833	
13	6.9231	7	7.0769	7.15	7.2308	7.3077	7.3846	7.4615	
14	6.4286	6.5	6.5714	6.64	6.7143	6.7857	6.8571	6.9286	14
15	6	6.0667	6.1333	6.2	6.2667	6.3333	6.4	6.4667	15
16	5.625	5.6875	5.75	5.8125	5.875	5.9375	6	6.0625	16
17	5.2941	5.3529	5.4118	5.4706	5.5294	5.5882	5.6471	5.7059	17
18	5	5.0556	5.1111	5.1667	5.2222	5.2778	5.3333	5.3889	18
19	4.7368	4.7895	4.8421	4.8947	4.9474	5	5.0526	5.1053	19
20	4.5	4.55	4.6	4.65	4.7	4.75	4.8	4.85	20
21	4.2857	4.3333	4.381	4.4286	4.4762	4.5238	4.5714	4.619	21
22	4.0909	4.1364	4.1818	4.2273	4.2727	4.3182	4.3636	4.4091	22
23	3.913	3.9565	4	4.0435	4.087	4.1304	4.1739	4.2174	23
24		3.7917	3.8333	3.875	3.9167	3.9583	4	4.0417	24
25		3.64	3.68	3.72	3.76	3.8	3.84	3.88	25
26	3.4615	3.5	3.5385	3.57	3.6154	3.6538	3.6923	3.7308	26
27	3.3333	3.3704	3.4074	3.44	3.4815	3.5185	3.5556	3.5926	27
28	3.2143	3.25	3.2857	3.32	3.3571	3.3929	3.4286	3.4647	28
29	3.1034	3.1379	3.1724	3.20	3.2414	3.2759	3.3103	3.344	29
30		3.0333	3.0667	3.1	3.1333	3.1667	3.2	3.23	30
31	2.9032	2.9355	2.9677	3	3.0323	3.0645	3.0968	3.129	31
32	2.8125	2.8438	2.875	2.90	2.9375	2.9688	3	3.0313	32
33	2.7273	2.7576	2.7879	2.818	2.8485	2.8788	2.9091	2.9394	33
34	2.6471	2.6765	2.7059	2.7353	2.7647	2.7941	2.8235	2.8529	34
35	2.5714	2.6	2.6286	2.6571	2.6857	2.7143	2.7429	2.7714	35
36	2.5	2.5278	2.5556	2.5833	2.6111	2.6389	2.6667	2.6944	36
37	2.4324	2.4595	2.4865	2.5135	2.5405	2.5676	2.5946	2.6216	37
38	2.3684	2.3947	2.4211	2.4474	2.4737	2.5	2.5263	2.5526	38
39	2.3077	2.3333	2.359	2.3846	2.4103	2.4359	2.4615	2.4872	39
40	2.25	2.275	2.3	2.325	2.35	2.375	2.4	2.425	40
41	2.1951	2.2195	2.2439	2.2683	2.2927	2.3171	2.3415	2.3659	41
42	2.1429	2.1667	2.1905	2.2143	2.2381	2.2619	2.2857	2.3095	42
43	2.093	2.1163	2.1395	2.1628	2.186	2.2093	2.2326	2.2558	43
44	2.0455	2.0682	2.0909	2.1136	2.1364	2.1591	2.1818	2.2045	44
45	2	2.0222	2.0444	2.066	2.0889	2.1111	2.1333	2.1556	45
46	1.9565	1.9783	2	2.021	2.0435	2.0652	2.087	2.1087	46
47	1.9149	1.9362	1.9574	1.978	2	2.0213	2.0426	2.0638	47
48	1.875	1.8958	1.9167	1.937	1.9583	1.9792	2	2.0208	48
49	1.8367	1.8571	1.8776	1.898	1.9184	1.9388	1.9592	1.9796	49
50	1.8	1.82	1.84	1.86	1.88	1.9	1.92	1.94	50
51	1.7647	1.7843	1.8039	1.823	1.8431	1.8627	1.8824	1.902	51
52	1.7308	1.75	1.7692	1.788	1.8077	1.8269	1.8462	1.866	52
53	1.6981	1.717	1.7358	1.754	1.7736	1.7925	1.8113	1.8302	53
54	1.6667	1.6852	1.7037	1.722	1.7407	1.7593	1.7778	1.7963	54
55	1.6364	1.6545	1.6727	1.6909	1.7091	1.7273	1.7455	1.7636	55
56	1.6071	1.625	1.6429	1.6607	1.6786	1.6964	1.7143	1.7321	56
57	1.5789	1.5965	1.614	1.6316	1.6491	1.6667	1.6842	1.7018	57
58	1.5517	1.569	1.5862	1.6034	1.6207	1.6379	1.6552	1.6724	58
59	1.5254	1.5424	1.5593	1.5763	1.5932	1.6102	1.6271	1.6441	59
60	1.5	1.5167	1.5333	1.55	1.5667	1.5833	1.6	1.6167	60
61	1.4754	1.4918	1.5082	1.5246	1.541	1.5574	1.5738	1.5902	61
62	1.4516	1.4677	1.4839	1.5	1.5161	1.5323	1.5484	1.5645	62
63	1.4286	1.4444	1.4603	1.4762	1.4921	1.5079	1.5238	1.5397	63
64	1.4063	1.4219	1.4375	1.4531	1.4688	1.4844	1.5	1.5156	64
65	1.3846	1.4	1.4154	1.4308	1.4462	1.4615	1.4769	1.4923	65
66	1.3636	1.3788	1.3939	1.4091	1.4242	1.4394	1.4545	1.4697	66
67	1.3433	1.3582	1.3731	1.3881	1.403	1.4179	1.4328	1.4478	67
68	1.3235	1.3382	1.3529	1.3676	1.3824	1.3971	1.4118	1.4265	68
69	1.3043	1.3188	1.3333	1.3478	1.3623	1.3768	1.3913	1.4058	69
70	1.2857	1.3	1.3143	1.3286	1.3429	1.3571	1.3714	1.3857	70
71	1.2676	1.2817	1.2958	1.309	1.3239	1.338	1.3521	1.3662	71
72	1.25	1.2639	1.2778	1.291	1.3056	1.3194	1.3333	1.3472	
	1.2329	1.2466	1.2603	1.27	1.2877	1.3014	1.3151	1.328	
	1.2162	1.2297	1.2432	1.25	1.2703	1.2838	1.2973	1.3	
		1.2133	1.2267	1.24	1.2533	1.2667	1.28	1.2	

Gear/Sprocket Ratio Chart

Driven Gear/Sprocket Teeth

Drive Gear/Sprocket Teeth

	99	100	101	102	103	104	
[illegible]	9.8	9.9	10.	10.2	10.3	10.4	10.5
[illegible]	8.9091	9	9.0909	9.1[illegible].2727	9.3636	9.4545	9.5455
[illegible]	8.1667	8.25	8.3333	8.4[illegible].5	8.5833	8.6667	8.75
13	7.5385	7.6154	7.6923	7.7[illegible].8462	7.9231	8	8.0769
14	7	7.0714	7.1429	7.2143	7.3571	7.4286	7.5
15	6.5333	6.6	6.6667	6.7333	6.8	6.8667	6.9333	7
16	6.125	6.1875	6.25	6.3125	6.375	6.4375	6.5	6.5625
17	5.7647	5.8235	5.8824	5.9412	6	6.0588	6.1176	6.1765
18	5.4444	5.5	5.5556	5.6111	5.6667	5.7222	5.7778	5.8333
19	5.1579	5.2105	5.2632	5.3158	5.3684	5.4211	5.4737	5.5263
20	4.9	4.95	5	5.05	5.1	5.15	5.2	5.25
21	4.6667	4.7143	4.7619	4.8095	4.8571	4.9048	4.9524	5
22	4.4545	4.5	4.5455	4.5909	4.6364	4.6818	4.7273	4.7727
23	4.2609	4.3043	4.3478	4.3913	4.4348	4.4783	4.5217	4.5652
24	4.0833	4.125	4.1667	4.2083	4.25	4.2917	4.3333	4.375
25	3.92	3.96	4	4.04	4.08	4.12	4.16	4.2
26	3.7692	3.8077	3.8462	3.88	3.9231	3.9615	4	4.0385
27	3.6296	3.6667	3.7037	3.74	3.7778	3.8148	3.8519	3.8889
28		3.5357	3.5714	3.60	3.6429	3.6786	3.7143	3.75
29	3.3793	3.4138	3.4483	3.48	3.5172	3.5517	3.5862	3.6207
30	3.2667	3.3	3.3333	3.36	3.4	3.4333	3.4667	3.5
31	3.1613	3.1935	3.2258	3.25	3.2903	3.3226	3.3548	3.38
32	3.0625	3.0938	3.125	3.15	3.1875	3.2188	3.25	3.28
33	2.9697	3	3.0303	3.0606	3.0909	3.1212	3.1515	3.1818
34	2.8824	2.9118	2.9412	2.9706	3	3.0294	3.0588	3.0882
35	2.8	2.8286	2.8571	2.8857	2.9143	2.9429	2.9714	3
36	2.7222	2.75	2.7778	2.8056	2.8333	2.8611	2.8889	2.9167
37	2.6486	2.6757	2.7027	2.7297	2.7568	2.7838	2.8108	2.8378
38	2.5789	2.6053	2.6316	2.6579	2.6842	2.7105	2.7368	2.7632
39	2.5128	2.5385	2.5641	2.5897	2.6154	2.641	2.6667	2.6923
40	2.45	2.475	2.5	2.525	2.55	2.575	2.6	2.625
41	2.3902	2.4146	2.4390	2.4634	2.4878	2.5122	2.5366	2.561
42	2.3333	2.3571	2.3810	2.4048	2.4286	2.4524	2.4762	2.5
43	2.2791	2.3023	2.3256	2.3488	2.3721	2.3953	2.4186	2.4419
44	2.2273	2.25	2.2727	2.2955	2.3182	2.3409	2.3636	2.3864
45	2.1778	2.2	2.2222	2.2444	2.2667	2.2889	2.3111	2.3333
46	2.1304	2.1522	2.1739	2.195[illegible]	[illegible].2174	2.2391	2.2609	2.2826
47	[illegible].0851	2.1064	2.1277	2.148[illegible]	[illegible].2702	2.1915	2.2128	2.234
48	[illegible].0417	2.0625	2.0833	2.104[illegible]	[illegible].25	2.1458	2.1667	2.1875
49		2.0204	2.0408	2.061[illegible]	[illegible].0816	2.102	2.1224	2.1428
50	1.96	1.98	2.0	2.02[illegible]	[illegible].04	2.06	2.08	2.1
51	1.9216	1.9412	1.9608	1.98[illegible]	[illegible].9804	2.0196	2.0392	2.0588
52	1.8846	1.9038	1.9231	1.94[illegible]	[illegible].9615	1.9808	2	2.0192
53	1.8491	1.8679	1.8868	1.90[illegible]	[illegible].9245	1.9434	1.9623	1.9811
54	1.8148	1.8333	1.8519	1.87[illegible]	[illegible].8889	1.9074	1.9259	1.9444
55	1.7818	1.8	1.8182	1.83[illegible]	[illegible].8545	1.8727	1.8909	1.9091
56	1.75	1.7679	1.7857	1.8036	1.8214	1.8393	1.8571	1.875
57	1.7193	1.7368	1.7544	1.7719	1.7895	1.807	1.8246	1.8421
58	1.6897	1.7069	1.7241	1.7414	1.7586	1.7759	1.7931	1.8103
59	1.661	1.678	1.6949	1.7119	1.7288	1.7458	1.7627	1.7797
60	1.6333	1.65	1.6667	1.6833	1.7	1.7167	1.7333	1.75
61	1.6066	1.623	1.6393	1.6557	1.6721	1.6885	1.7049	1.7213
62	1.5806	1.5968	1.6129	1.629	1.6452	1.6613	1.6774	1.6935
63	1.5556	1.5714	1.5873	1.6032	1.619	1.6349	1.6508	1.6667
64	1.5313	1.5469	1.5625	1.5781	1.5938	1.6094	1.625	1.6406
65	1.5077	1.5231	1.5385	1.5538	1.5692	1.5846	1.6	1.6154
66	1.4848	1.5	1.5152	1.5303	1.5455	1.5606	1.5758	1.5909
67	1.4627	1.4776	1.4925	1.5075	1.5224	1.5373	1.5522	1.5672
68	1.4412	1.4559	1.4706	1.4853	1.5	1.5147	1.5294	1.5441
69	1.4203	1.4348	1.4493	1.4638	1.4783	1.4928	1.5072	1.5217
70	1.4	1.4143	1.4286	1.4429	1.4571	1.4714	1.4857	1.5
71	1.3803	1.3944	1.4085	1.4225	1.4366	1.4507	1.4648	1.4789
72	1.3611	1.375	1.3889	1.4028	1.4167	1.4306	1.4444	1.4583
[illegible]	[illegible].3425	1.3562	1.3699	1.3836	1.3973	1.411	1.4247	1.4384
[illegible]	[illegible].3243	1.3378	1.3514	1.3649	1.3784	1.3919	1.4054	1.4189
[illegible]	[illegible].3067	1.32	1.3333	1.3467	1.36	1.3733	1.3867	1.4

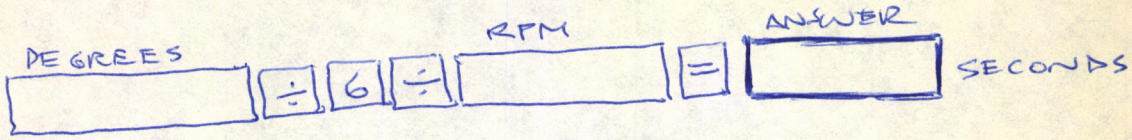
3/4/85

TIME-FACTOR FOR DEGREES OF CRANKSHAFT ROTATION

- ANSWER GIVEN IN SECONDS AND DECIMAL FRACTION
- INPUT CAN BE ANY DEGREES AND ~~ANY~~ ANY RPM

$$\text{TIME-FACTOR} = \frac{60}{\text{RPM}} \cdot \frac{\text{DEGREES}}{360} \text{ SECONDS}$$

ENTER:



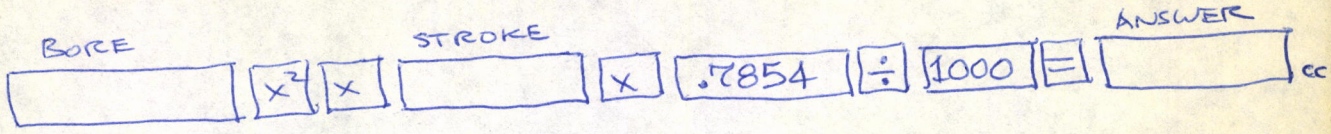
3/4/85

SINGLE CYLINDER DISPLACEMENT

FORMULA (1)

(FOR MILLIMETER BORE AND STROKE)

ENTER:

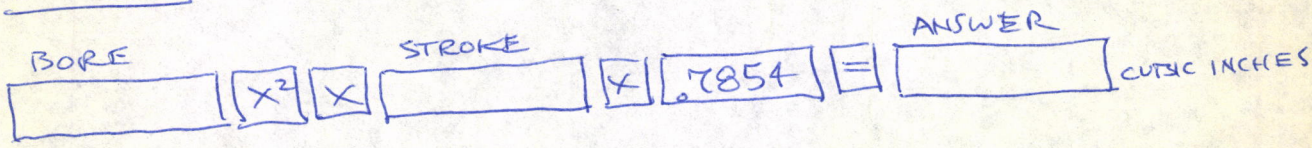


SINGLE CYLINDER DISPLACEMENT

FORMULA (2)

(FOR INCH BORE AND STROKE)

ENTER:

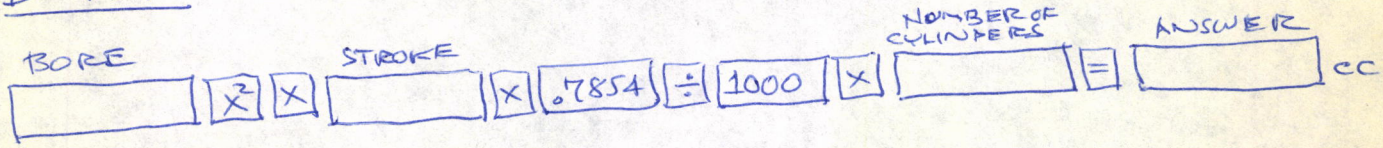


TOTAL ENGINE DISPLACEMENT

FORMULA (3)

(FOR MILLIMETER BORE AND STROKE)

ENTER:

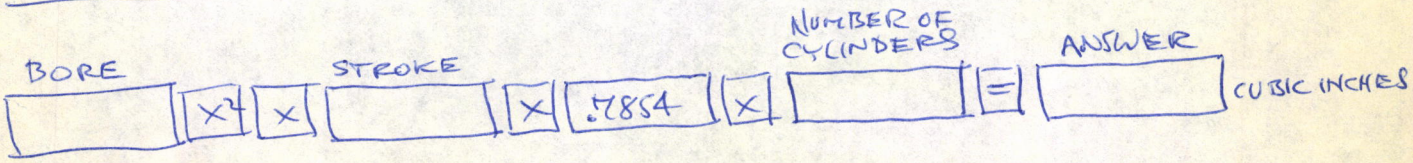


TOTAL ENGINE DISPLACEMENT

ETC. W/ ALL FORMULAS

(FOR INCH BORE AND STROKE)

ENTER:



3/4/85

RPM = (MEAN PISTON SPEED) (x 6) / STROKE, IN INCHES

GIVEN:

MEAN PISTON SPEED = _____ FT/MIN

STROKE = _____ INCHES

ENTER:

MEAN PISTON SPEED [ ] [x] [6] [÷] STROKE [ ] [=] ANSWER [ ] RPM

= (MEAN PISTON SPEED) (152.4) / STROKE, IN MILLIMETERS

GIVEN:

MEAN PISTON SPEED = _____ FT/MIN

STROKE = _____ MILLIMETERS

ENTER:

MEAN PISTON SPEED [ ] [x] [152.4] [÷] STROKE [ ] [=] ANSWER [ ] RPM

BORE-TO-STROKE RATIO

ENTER:

BORE, INCHES [ ] [÷] STROKE IN INCHES [ ] [=] ANSWER [ ] :1

ENTER:

BORE IN MM [ ] [÷] STROKE IN MM [ ] [=] ANSWER [ ] :1

ROD LENGTH ~~CENTER TO CENTER~~ -TO-STROKE RATIO

ENTER:

ROD LENGTH IN INCHES [ ] [÷] STROKE IN INCHES [ ] [=] ANSWER [ ] :1

ENTER:

ROD LENGTH IN MM [ ] [÷] STROKE IN MM [ ] [=] ANSWER [ ] :1

3/9/85

MEAN PISTON SPEED

BDD COSWORTH

1. ALL DIMENSIONS IN INCHES

GIVEN:

STROKE..... = 3.0591 INCHES

RPM..... = 10500 RPM

ENTER:

STROKE		RPM					ANSWER	
3.0591	X	10500	÷	6	=		5353.425	FT/MIN

GIVEN:

PISTON TRAVEL..... = 3.0591 INCHES

RPM..... = 10500 RPM

DEGREES OF CRANK ROTATION... = 180 DEGREES

ENTER:

15.2955 INV(.0654...)

INCHES ~~PISTON TRAVEL~~					DEGREES			RPM			ANSWER	
3.0591	X	5	÷	(	180	÷	6	÷	10500	)	=	5353.425 FT/MIN

GIVEN:

PISTON TRAVEL..... = 3.0591 INCHES

~~SE~~ TRAVEL TIME..... = .0028566 SECONDS

ENTER:

INCHES				SECONDS		ANSWER	
3.0591	X	5	÷	.0028566	=	5354.4423	FT/MIN

NEED FT/SEC. ?

NEED CFM

3/9/85

BDD COSWORTH

MEAN PISTON SPEED

1. ALL DIMENSIONS IN MILLIMETERS

GIVEN:

STROKE ..... = 77.701 MM

RPM ..... = 10500 RPM

ENTER:

STROKE 77.701 × RPM 10500 ÷ 152.4 = ANSWER 5353.4154 FT/MIN

GIVEN:

PISTON TRAVEL ..... = 77.701 MM

DEGREES OF CRANKSHAFT ROTATION ... = 180 DEGREES

RPM ..... = 10500 RPM

ENTER:

MM 77.701 ÷ 5.08 ÷ (DEGREES 180 .....

÷ 6 ÷ RPM 10500) = ANSWER 5353.4154 FT/MIN

GIVEN:

PISTON TRAVEL .... = 77.701 MM

TRAVEL TIME .... = .0028566 SECONDS

ENTER:

MM 77.701 ÷ 5.08 ÷ SECONDS .0028566 = ANSWER 5354.4327 FT/MIN

NEED FT/SEC ?

3/4/85

MEAN PISTON SPEED = $\frac{(\text{STROKE, IN INCHES})(\text{RPM})}{6}$

GIVEN: STROKE = [ ] INCHES

ENGINE RPM = [ ] RPM

ENTER:

STROKE		RPM		6		ANSWER	
[ ]	X	[ ]	÷		=	[ ]	FT/MIN

$= \frac{(\text{STROKE, IN MILLIMETERS})(\text{RPM})}{152.4}$

GIVEN: STROKE = [ ] MILLIMETERS

ENGINE RPM = [ ] RPM

ENTER:

STROKE		RPM		152.4		ANSWER	
[ ]	X	[ ]	÷		=	[ ]	FT/MIN

STROKE, IN INCHES = $\frac{(\text{MEAN PISTON SPEED})(6)}{\text{RPM}}$

GIVEN: MEAN PISTON SPEED = [ ] FT/MIN

ENGINE RPM = [ ] RPM

ENTER:

MEAN PISTON SPEED		6		RPM		ANSWER	
[ ]	X		÷	[ ]	=	[ ]	INCHES

$= \frac{(\text{MEAN PISTON SPEED})(152.4)}{\text{RPM}}$

, IN MM

GIVEN: MEAN PISTON SPEED = [ ] FT/MIN

ENGINE SPEED = [ ] RPM

ENTER:

MEAN PISTON SPEED		152.4		RPM		ANSWER	
[ ]	X		÷	[ ]	=	[ ]	MM

3/4/85

TOTAL ROD SWING ANGLE UNDER WRIST PIN

- WHEN MAXIMUM PISTON VELOCITY OCCURENCE DEGREES IS KNOWN (FOR NON-OFFSET WRIST PIN AND CYLINDER BORE)

GIVEN: MAXIMUM PISTON VELOCITY OCCURENCE = [ ] DEGREES ATDC

ENTER:

[90] [−] [DEGREES] [=] [×] [2] [=] [ANSWER] DEGREES OF ROD SWING INCLUDED ANGLE

TOTAL ROD SWING ANGLE UNDER WRIST PIN

- WHEN ONLY STROKE AND ROD LENGTH ARE KNOWN
- STROKE AND ROD LENGTH TO BE IN EITHER MILLIMETERS OR INCHES

GIVEN: STROKE = [BDD 77.701] MM/INCHES

ROD LENGTH = [132.791] MM/INCHES

ENTER:

[ROD LENGTH 132.791] [÷] [STROKE 77.701] [×] [2] [=] [INV] [TAN] [+/−] [+] [90] .....

[=] [×] [2] [=] [ANSWER 32.615656] INCLUDED ANGLE DEGREES OF TOTAL ROD SWING

3/8/85

DICK - IN CASE YOU NEED A SINGLE PURPOSE FORMULA FOR PEAK PISTON VELOCITY, THIS IS CLOSE. THE PISTON TRAVEL STARTS AT THE BELOW CONDITION. THEN THE PISTON TRAVELS FOR 1.5-DEGREES FURTHER. IF I KNEW ANYTHING AT ALL ABOUT TRIG, I KNOW I COULD TAKE A SHOVEL TO SOME KEY STROKES.

BDD COSWORTH

STROKE = 3.0591"
ROD LENGTH = 5.228"
RPM = 10,500

ADDITIONAL PISTON TRAVEL

+ .5 DEGREE	(8762.4665 FT/MIN)
+ 1.0 DEGREE	(8763.0102 ")
✓ + 1.5 DEGREES	(8763.2689 ")
+ 2.0 DEGREES	(8763.2565 ")

PEAK PISTON VELOCITY:

RL [ ] ÷ S [ ] X 2 = INV TAN + 1.5 = ...

STO SIN X (S [ ] ÷ 2) ÷ RL [ ] = ...

INV SIN + RCL = +/- + 180 = SIN X RL [ ] .....

÷ RCL SIN = +/- + (S [ ] ÷ 2) + ...

RL [ ] = STO (S [ ] ÷ 2) X^2 + ...

RL [ ] X^2 = $\sqrt{X}$ +/- + (S [ ] ÷ 2 .....

) + RL [ ] = +/- + RCL = X 5 ÷ (1.5 ..... ⊗ PRE-ANSWER (TO FIND DIFF RPM)

÷ 6 ÷ RPM [ ]) = ANSWER [ ] FT/MIN

ALL INPUT IS MM

÷ 25.4 = IF

86 KEYS

CHEERS, Jeff

6/3/89

3/9/85

PEAK PISTON VELOCITY

GIVEN:

STROKE = _____ MM/INCH

ROD LENGTH = _____ MM/INCH

RPM = _____

FORMULA IS PISTON TRAVEL FROM 90° PIN TO PIN TO CRANK AXIS PLUS 1.5° MORE PISTON TRAVEL

ENTER: (FOR MM OR INCH DIMENSIONS)

RL [ ] ÷ S [ ] × 2 = INV TAN + 1.5 = STO SIN .....

× (S [ ] ÷ 2) ÷ RL [ ] = INV SIN + RCL .....

= +/- + 180 = SIN × RL [ ] ÷ RCL SIN = +/- + ...

(S [ ] ÷ 2) + RL [ ] = STO (S [ ] .....

÷ 2) x^2 + RL [ ] x^2 = $\sqrt{x}$ +/- + (S [ ] .....

÷ 2) + RL [ ] = +/- + RCL = × 5 ÷ (..... ⊗ WRITE DOWN FOR MULTIPLE RPM'S

1.5 ÷ 6 ÷ RPM [ ]) = ANSWER [ ] FT/MIN

(FOR MM DIMENSIONS): ÷ 25.4 = ANSWER [ ] FT/MIN

3/4/85

MAXIMUM PISTON VELOCITY OCCURENCE

NEED DIAGRAM!?

- FOR NON-OFFSET WRIST PIN AND CYLINDER BORE
- OCCURENCE GIVEN IN DEGREES BTDC AND ATDC
- ~~BORE~~ STROKE AND RODLENGTH ~~IN~~ TO BE EITHER MILLIMETERS OR INCHES IN

$$\text{TAN } A = \frac{\text{ROD LENGTH}}{\frac{1}{2}\text{ STROKE}}$$

ENTER:

ROD LENGTH		STROKE					ANSWER	
	÷		x	2	=	INV TAN		DEGREES BTDC ~~DEGREES~~ ATDC

FOR FORWARD OFFSET WRIST PIN OR CYLINDER BORE ~~CORRECTION OF CRANK~~ ROTATION

MAXIMUM PISTON VELOCITY OCCURENCE CORRECTION FACTOR

- FOR WRIST PIN OFFSET; NOT IN PISTON CENTER
- FOR CYLINDER BORE OFFSET; NOT CENTERED ~~OVER~~ CRANKSHAFT AXIS
- CORRECTION FACTOR GIVEN IN DEGREES
- OFFSET, STROKE, AND ROD LENGTH TO BE IN EITHER MILLIMETERS OR INCHES

NOTE: (FOR FORWARD OFFSET: IN DIRECTION OF CRANK ROTATION):

CORRECTION FACTOR DEGREES TO BE
SUBTRACTED FROM NON-OFFSET MAXIMUM PISTON VELOCITY OCCURENCE DEGREES BTDC, AND
ADDED TO NON-OFFSET MAXIMUM PISTON VELOCITY OCCURENCE DEGREES ATDC.

$$\text{SIN } A = \frac{\text{PIN OR CYLINDER OFFSET}}{(\frac{1}{2}\text{ STROKE})(\text{ROD LENGTH})}$$

ENTER:

WRIST PIN OR CYLINDER BORE OFFSET (FM BORE ℄)					STROKE		ROD LENGTH				ANSWER	
	÷	(	.5	x		+		)	=	INV SIN		DEGREES OF CORRECTION FACTOR

NOTE (FOR REARWARD OFFSET: IN OPPOSITE DIRECTION OF CRANK ROTATION):

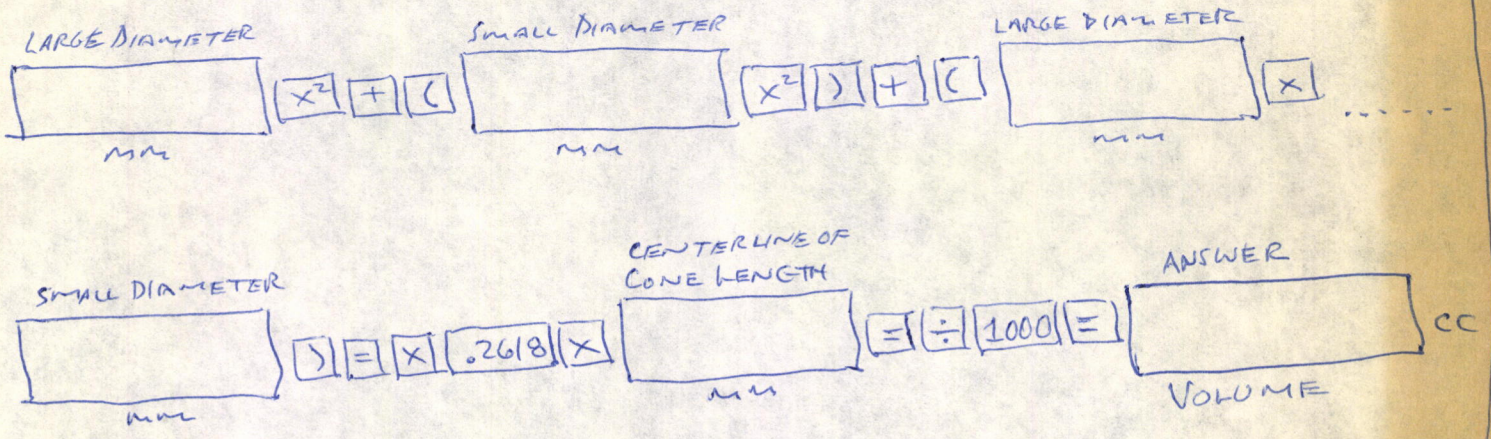
CORRECTION FACTOR DEGREES TO BE
ADDED TO NON-OFFSET MAXIMUM PISTON VELOCITY OCCURRENCE DEGREES BTDC, AND
SUBTRACTED FROM NON-OFFSET MAXIMUM PISTON VELOCITY OCCURENCE DEGREES ATDC.

POCKET CALCULATOR: TI-30 SLR (SOLAR) 12/5/87

FRUSTUM OF CONE VOLUME

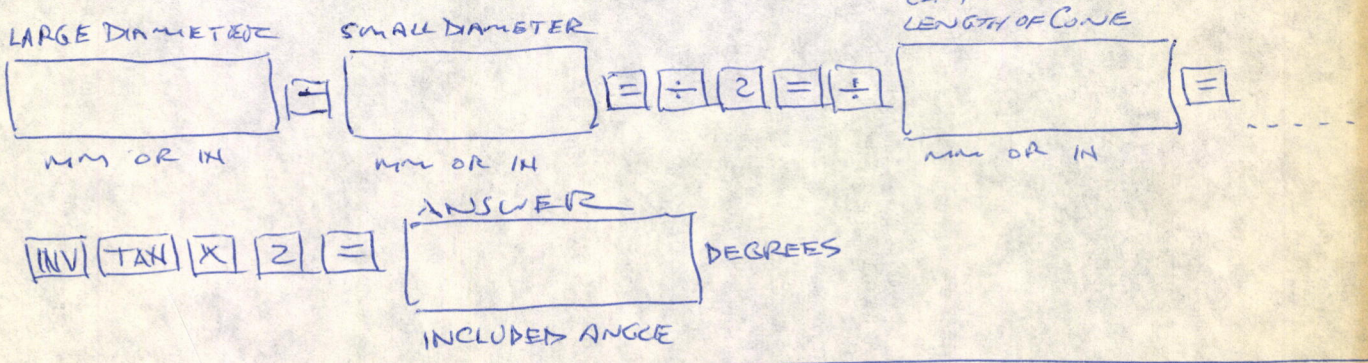
INPUT = MM
ANSWER = CC

ENTER:



FRUSTUM OF CONE INCLUDED ANGLE ~~OF CONE~~

INPUT = IN OR MM (MUST BE SAME THROUGHOUT)
ANSWER = DEGREES & DEGREE-DECIMAL



POCKET CALCULATOR: TI-30 SLR (SOLAR)

WAVE SPEED, FT/SEC OF TUNED LENGTH IN DRY AIR, 32°F

$$\frac{(\text{~~PEAK TORQUE~~ RPM})(\text{TUNED LENGTH})}{(\text{DURATION})} = \text{WAVE SPEED}$$

INPUT LENGTH: INCHES

ENTER:

PEAK TORQUE [ ] RPM × TUNED LENGTH [ ] INCHES ÷ EXH OPEN TO TRANSF CLOSE DURATION [ ] DEGREES = ANSWER [ ] FT/SEC

~~WAVE TUNED LENGTH~~ MEAN WAVE SPEED

INPUT LENGTH: MM

~~[ ]~~ ENTER:

PEAK TORQUE [ ] RPM × [(] TUNED LENGTH [ ] MM ÷ [25.4] [)] ÷ EXH OPEN TO TRANSF CLOSE DURATION [ ] DEGREES = ANSWER [ ] FT/SEC

MEAN WAVE SPEED

3/4/85

MAXIMUM PISTON ACCELERATION

- ACCELERATION GIVEN IN FEET PER SECOND, FOR 1 SECOND, OR FT/SEC-SEC, OR FT/SEC²
- STROKE AND ROD LENGTH TO BE IN ~~EITHER~~ MILLIMETERS

$$\text{MAXIMUM PISTON ACCELERATION} = \left[\frac{1}{(2)(\text{ROD LENGTH} \div \text{STROKE})} + 1\right]\left(\frac{(\text{RPM}^2)(\text{STROKE})}{55586}\right) \text{FT/SEC}^2$$

55600.6 ?

ENTER:

ROD LENGTH [ ] ÷ STROKE [ ] × 2 = 1/x + 1 = × RPM [ ] .....

x^2 × STROKE [ ] ÷ ~~55586~~ ~~55600.6~~ 55587.9 = ANSWER [ ] FT/SEC²

4225000

OK - 1/17/88

ANSWER FOR 84 STROKE/139.7 RL/6500 RPM = 83,039.44

3/4/88

MAXIMUM PISTON ACCELERATION

- ACCELERATION GIVEN IN FEET PER SECOND, FOR 1 SECOND, OR FT/SEC-SEC, OR FT/SEC²
- STROKE AND ROD LENGTH TO BE IN INCHES

$$\text{MAXIMUM PISTON ACCELERATION} = \left[\frac{1}{(2)(\text{ROD LENGTH} \div \text{STROKE})} + 1\right] \cdot \left(\frac{(\text{RPM}^2)\cdot(\text{STROKE})}{2188.4252}\right) \text{FT/SEC}^2$$

2189 ?

ENTER:

ROD LENGTH [ ] ÷ STROKE [ ] × 2 = 1/x + 1 = × RPM [ ] .....

x^2 × STROKE [ ] ÷ ~~2188.4252~~ 2188.5 = ANSWER [ ] FT/SEC²

OK - 1/17/88

ANSWER FOR 3.3070866" (84 mm) STROKE/5.5" (139.7 mm) ROD/6500 = 83,039.409

3/4/88

MILES PER GALLON FORMULAS

FORMULAS!

EXAMPLES

(FOR FRACTIONAL PARTS, USE DECIMAL EQUIVALENTS)

MILES PER HOUR FORMULAS

MILES PER HOUR (average) =

$$\frac{\text{MILES}}{\text{HOURS}} \quad \text{(or)} \quad \frac{60\,(\text{MILES})}{\text{MINUTES}} \quad \text{(or)} \quad \frac{3600\,(\text{MILES})}{\text{SECONDS}}$$

3 EXAMPLES (OR 6?)

LEFT

ROUGH DRAFT: 1.25.85

DISCUSSIONS FOR FOLLOWING 10-PAGE PRINTOUT SAMPLE

LINE

2) thru 4) Provides an instant conversion between millimeters and inches, depending upon one's familarity or preference of measurement procedures or methods.

5) Provides an instant conversion of Single Cylinder Displacement between cc's and cubic inches. Can be related to class bore and stroke rules and/or limitations.

6) Provides an instant conversion of Total Engine Displacement between cc's and cubic inches. Can be related to class displacement rules and/or limitations.

7) Some comparative engine analysis can be made between similar and dissimilar engines, generally by ratios, using the Bore-to-Stroke Ratio. Most engines covered by BRATTON'S BOOK printouts that will be of general interest to the engine enthusiast will ratios from .75:1 through 1.5:1.

8) Some comparative engine analysis can be made between similar and dissimilar engines, generally by ratios, using the Rod Length-to-Stroke Ratio. Most engines covered by BRATTON'S BOOK printouts that will be of general interest to the engine enthusiast will have ratios from 1.5:1 through 2.5:1.

9) Four variables control where the Peak Piston Speed occurs: stroke, rod length, cylinder bore offset (axially) over crankshaft centerline, and wrist pin offset from cylinder bore centerline (rearward or forward of). Altering any one of these variables will alter the peak piston speed occurende. Altering two or more of these variables in the right combination can result in the original peak piston speed occurence. Most engines covered by BRATTON'S BOOK printouts that will be of general interest to the engine enthusiast will have the peak piston speed occuring from 71 through 79-degrees BTDC and ATDC.

Speaking in very general terms, a low-end "torque" motor, such as a heavy duty tractor engine, will tend to have this peak piston speed occuring towards the low-degree (71) end of the range, while a top-end "horsepower" motor will tend to have this occurence towards the high-degree (79) end of the range.

There are, of course, countless other variables that will help dictate and determine where the peak piston speed occurence will be, or is desireable, depending upon the engine and the application.

10) This angle represents the total included "swing" angle that the rod makes ("swinging" from wrist pin) between the peak piston speed occurence BTDC and the peak piston speed occurence ATDC (and traveling through TDC). This angle is significant in that at a glance at the given value, some general assumptions can be made in regard to engine power-band type (high/low rpm), power-band width (narrow/wide), engine rpm upper limitations, and certain engine components' reliability.

(MUST EXPAND 10) A BIT)

COLUMN

11) This column, in conjunction with columns 12) or 13), is useful in graphing how long a piston will "set" close to TDC, for several degrees BTDC and ATDC, in comparison with other engines of known values. The important consideration here is the type of power-band desired, and therefore, plays an important part in the selection of a cam. Rod length and/or stroke changes will alter this piston position curve.

A shorter rod and/or a longer stroke (than existing) results in the piston accelerating from (and decelerating to) TDC a bit quicker. A piston moving away from TDC more quickly will generally have better cylinder breathing potential typical of engines with good low-end and mid-range power.

A longer rod and/or a shorter stroke (than existing) results in the piston accelerating from (and decelerating to) TDC a bit slower. A piston moving away from TDC more slowly will generally have better cylinder breathing potential typical of engines with good mid-range and top-end power.

Designing cam profiles - which control valve closing and opening times and rates, and durations - take this information, as well as port flow capabilities, into consideration in order to take advantage of a cylinder's breathing potential. Valve float is an important aspect here - especially with a lot of overlap valve timing - as the longer a piston remains near TDC, the more critical the nature of valve float becomes, increasing the possibility of valve-to-piston contact.

All time-period calculations, involving piston movement and valve train actuation, will include the use of this column. Degreeing in a cam may involve this column as a check upon one's work.

Ignition timing curves can be graphed using this, and other, columns.

Realize too, that this column may represent another aspect of an engine's operating cycle. If, for example, you are working on the power stroke, add 360 to the numbers in this column when working on the 720-degree basis.

12) See discussion column 11). This column also provides an instant conversion from engines using inch measurements.

13) See discussion column 11). This column also provides an instant conversion from engines using metric measurements.

14). Using CFM formulas, this column is useful in the aid of cam design. See discussion column 11). This column also provides an instant conversion from engines using cubic inch displacement.

15) This column also provides an instant conversion from engines using cubic centimeters displacement.

16) At a glance, one can look at this column and see how "quick" the piston leaves TDC when compared to any other engine combination. An excellent column for comparative analysis work in regards to different engine set_ups of known and successful applications. Different engine applications will require different powerband types. A pavement racing engine will require strong mid-range and very strong high-rpm power, whereas an oval dirt-tracker, using the same engine, will require strong low-end and very strong mid-range power at a much lower rpm. A shorter rod length might be required for the latter.

COLUMN

17) See discussion, column 11).

18) See discussion, column 12).

19) See discussion, column 13).

20) See discussion, column 14).

21) See discussion, column 15).

22) See discussion, column 16).

COLUMN

¢#

23) See discussion, column 11).

24) See discussion, column 12).

25) See discussion, column 13).

26) See discussion, column 14).

27) See discussion, column 15).

28) See discussion, column 16).

COLUMN

30) The Mean (average) Piston Speed is a function of an engine's stroke and rpm. Whereas the stroke or rpm of a model airplane engine cannot, for any practical purpose, be compared to the stroke or rpm of a locomotive diesel engine, the mean piston speed of both can be compared. A very valuable comparative analysis value. The mean piston speed is important in many formulas.

The peak torque rpm for all piston engines can be compared - within application catagories - using the mean piston speed for the peak torque rpm. Most engines covered by BRATTON'S BOOK printouts that will be of general interest to the engine enthusiast will have peak torque rpm, regardless of application, occuring from 2200 through 4200-ft/min mean piston speed.

The highest volumetric efficiency of an engine occurs at the peak torque rpm.

The peak horspower rpm for all piston engines can be compared - within application catagorees - using the mean piston speed for the peak horsepower rpm.

The maximum air flow through an engine (generally given in CFM) occurs at the peak horsepower rpm.

The maximum permissible rpm of all piston engines can also be compared, when presented as a mean piston speed. A 51-mm stroke (about 2") redlined at 12500-rpm gives 4180-ft/min piston speed. A 102-mm stroke (about 4") redlined at 6250-rpm gives the same mean piston speed.

31) The Peak Piston Speed of an engine is a function of an engine's stroke, rod length, and rpm. The peak piston speed is an important variable used by a number of cam manufacturers in the design phase of cam profiles.

32) The Maximum Piston Acceleration rates are also a function of an engine's stroke, rod length, and rpm. These acceleration rates are very useful in determining the loads and stresses of various component parts. Ring flutter, popping the top ring land off, yanking the wrist pin bosses out of the bottom of a piston, and snapping the connecting rod beam - most of us have heard the stories - are often the result of component parts that have exceeded their load and stress ratings.

33) If extensive engine work has been accomplished, oil requirements (volume, pressure, temperature, and/or flow rate) will change. This column may provide useful information that might help in solving for new requirements.

34) Time-factors are used in all the design phases of the tuned intake and exhaust systems, cam designs, and in the calculations of all inertial load and acceleration problems of the various engine components where time is a considering variable.

COLUMN

35) Since cylinder head flow and related camshaft design are often considered the two most important aspects of an engine's power potential and characteristics (carburetion, compression ratio, ignition, and tuned intake and exhaust systems are the variables that should optimize a good cylinder head and camshaft combination), this column will permit a little closer look (rpm increment of 50) in the general area of peak torque and peak horsepower rpm - even when these are not known.

36) See discussion, Column 30).

37) See discussion, Column 31).

38) See discussion, Column 57). The Peak Piston Speed CFM column is calculated for 100% volumetric efficiency under ideal atmospheric conditions. (STATE CONDITIONS???)

This column can provide part of the ratio or percentage against which actual CFM requirements, when they are known, can be compared. or conditions,

39) thru 45) When the maximum intake valve lift occurence is known, in crankshaft degrees ATDC, the CFM given in these columns can be extrapolated and then graphed for all rpm for a theoretical CFM at maximum valve lift. When actual CFM conditions are known, or calculated, these can be placed on the graph for ratio or percentage studies when compared with the theoretical CFM graph. Valve timing and lift curves may also be employed. Other formulas can enter the picture, if additionally, if peak torque and/or peak horsepower rpm is known.

(IS A DISCUSSION OF Ve, CR, COMBUSTION EFFICIENCY, ETC., NECESSARY AT THIS TIME????)

COLUMN

46) See discussion, Column 35).

47) See discussion, Column 57) and 38).

48) thru 56) (IN PROCESS OF DEVELOPING....)

COLUMN

57) With the piston at TDC, the trapped volume above the piston is con-
59) sidered as unswept or "dead" volume. The cylinder displacement, the
61) result of bore and stroke only (the rod length has no affect on dis-
63) placement), is considered as swept or "live" volume. The compression ratio number we are all familar with is a mathematical comparison: the "dead" volume plus the "live" volume, divided by the "dead" volume. The result is expressed as a ratio number to one, e.g., 10:1.

This mathematical compression ratio, CR, is theoretical in nature because any stated CR always assumes a volumetric efficiency, Ve, of 100%. A 100 cubic inch cylinder, operating at 100% Ve, will draw in and trap 100 cubic inches of intake charge. The problem with this is the fact that very few engines operate at 100% Ve. Most spark-ignition piston engines operate at less while a few operate with higher Ve. And there are squish variables, shrouding variables, heat dissipation losses, etc., to consider in estimating the combustion efficiency of whatever charge is drawn into the cylinder. Between the fuel tank and the rear tire, there is certainly many variables to consider.

Take a fresh engine in good tune. 10:1 CR. If its Ve is 90%, the actual (effective) CR is about 9:1. Throw in worn cylinders and pistons, loose rings, sloppy valve guides, weak ignition, and a badly adjusted carburetor. The Ve may now be 75%. Now we're down to about 7.5:1. But wait. Perhaps the combustion efficiency of the cylinder head chamber is down for the tired engine. So, while the engine retains about 65% of its original power output rating, the CR is still rated at 10:1.

We must realize that stated CR figures are relative to many variables. If a modified engine is running great with 12:1 pistons, those same type pistons will be the ones to use for rebuilds, regardless if actual CR is 8:1 or 13:1.

In reality, there may be more education in using a cylinder compression guage in checking the engine's cranking compression pressure - although this is almost impossible with some engines and can't be done.

58) The resultant cc's given is the universal measurement used. Altering
60) one or more of the following will alter all the values given in Section
62) XI: bore, stroke, head volume, head gasket design or thickness, piston
64) dome height and/or sometimes shape, piston compression distance, or cylinder decking height distance from the crankshaft centerline. An identical CR may be obtained with the right combination of alterations of two or more of these items.

Although a rod length change (made in conjuction with a comparable cylinder and/or piston change to compensate) has no altering affect on the mathematical CR, there may be a change in the effective CR due to the altering of a cylinder's breathing characteristics. It is thusly easily realized the importance of proper valve timing and cylinder head, combustion chamber, and piston design.

65) thru 75) These columns provide the cylinder bores, with a given range of stroke values, for a selectable range of total engine capacity. The value here is for those class rules where total engine displacement is stated, but altering the bore and stroke are permitted.

COLUMN

76) This column provides a selectable range of cylinder bores for those wishing to alter this variable.

77) thru 82) These columns provide a range of stroke values for those wishing to alter this variable. The single cylinder and total engine displacement is given for each cylinder bore, along with the bore-to-stroke ratio, as this is the relationship most of us are familar with.

Of course, a combination of the cylinder decking distance from the crankshaft centerline, the piston compression distance, or the rod length may have to also be altered in order to compensate for a stroke change.

Keep in mind that modern practice and design concepts permit, in general, bore-to-stroke ratios ranging from .75:1 through 1.5:1. And that the higher ratios (more over-square design) generally yield the higher output per unit of displacement (e.g., 2.1-hp per cubic inch, or, 200-hp per liter).

COLUMN

83) This column provides a selectable range of rod lengths for those wishing to alter this variable. Of course, the cylinder decking distance from the crankshaft centerline and/or the piston compression distance will have to be altered in order to compensate for a rod length change. Occasionally, a rod length change in conjunction with a stroke change (and possibly a piston compression height change) will not require the alteration of the cylinder decking distance.

84) thru 89) These columns provide the crankshaft phasing degrees where the peak piston speed occurence will be for each change in rod length for the range of stroke values as given in Section XIII.

Also given are the rod length-to-stroke ratic values, as this is the relationship most of us are familar with.

Keep inmind that modern engine practice and design concepts permit, generally, rod length-to-stroke ratios ranging from 1.5:1 through 2.5:1. What determines the ratio used for a given application? Space considerations sometimes play an important part. As for the engine enthusiast looking for more power output, however, this consideration is often of little concern.

One must consider, first of all, what were the original application considerations for the engine in question. Some deductions must then be made as to any intended alternative application. After all, it is probably easier to get a 50% increase in output out of an old Ford Falcon motor than to get a 5% increase out of a Cosworth DFV Formula I engine.

FUEL-OIL RATIOS

DESIRED RATIO	AMOUNT OF FUEL TO BE MIXED										
	5 gal	4.5 gal	4 gal	3 gal	2 gal	1.5 gal	1 gal	3 qt	2 qt	1 qt	1 pt
10:1	64.00	57.60	51.20	38.40	25.60	19.20	12.80	9.60	6.40	3.20	1.60
12:1	53.33	48.00	42.67	32.00	21.33	16.00	12.67	8.00	5.33	2.67	1.33
14:1	45.71	41.14	36,57	27.43	18.29	13.71	9.14	6.86	4.57	2.29	1.14
16:1	40.00	36.00	32.00	24.00	16.00	12.00	8.00	6.00	4.00	2.00	1.00
18:1	35.56	32.00	28.44	21.33	14.22	10.67	7.11	5.33	3.56	1.78	0.89
20:1	32.00	28.80	25.60	19.20	12.80	9.60	6.40	4.80	3.20	1.60	0.80
22:1	29.09	26.18	23.27	17.45	11.64	8.73	5.82	4.36	2.91	1.45	0.73
24:1	26.67	24.00	21.33	16.00	10.67	8.00	5.33	4.00	2.67	1.33	0.67
26:1	24.62	22.15	19.69	14.77	9.85	7.38	4.92	3.69	2.46	1.23	0.62
28:1	22.86	20.57	18.29	13.71	9.14	6.86	4.57	3.43	2.29	1.14	0.57
30:1	21.33	19.20	17.07	12.80	8.53	6.40	4.27	3.20	2.13	1.07	0.53
32:1	20.00	18.00	16.00	12.00	8.00	6.00	4.00	3.00	2.00	1.00	0.50
34:1	18.82	16.94	15.06	11.29	7.53	5.65	3.76	2.62	1.88	0.94	0.47
36:1	17.78	16.00	14.22	10.67	7.11	5.33	3.56	2.67	1.78	0.89	0.44
38:1	16.84	15.16	13.47	10.11	6.74	5.05	3.37	2.53	1.68	0.84	0.42
40:1	16.00	14.40	12.80	9.60	6.40	4.80	3.20	2.40	1.60	0.80	0.40
42:1	15.24	13.71	12.19	9.14	6.10	4.57	3.05	2.29	1.52	0.76	0.38
44:1	14.55	13.09	11.64	8.73	5.82	4.36	2.91	2.18	1.45	0.73	0.36
46:1	13.91	12.52	11.13	8.35	5.57	4.17	2.78	2.09	1.39	0.70	0.35
48:1	13.33	12.00	10.67	8.00	5.33	4.00	2.67	2.00	1.33	0.67	0.33
50:1	12.80	11.52	10.24	7.68	5.12	3.84	2.56	1.92	1.28	0.64	0.32
60:1	10.67	9.60	8.53	6.40	4.27	3.20	2.13	1.60	1.07	0.53	0.27
70:1	9.14	8.23	7.31	5.49	3.66	2.74	1.83	1.37	0.91	0.46	0.23
80:1	8.00	7.20	6.40	4.80	3.20	2.40	1.60	1.20	0.80	0.40	0.20
90:1	7.11	6.40	5.69	4.27	2.84	2.13	1.42	1.07	0.71	0.36	0.18
100:1	6.40	5.76	5.12	3.84	2.56	1.92	1.28	0.96	0.64	0.32	0.16
150:1	4.27	3.84	3.41	2.56	1.71	1.28	0.85	0.64	0.43	0.21	0.11
200:1	3.20	2.88	2.56	1.92	1.28	0.96	0.64	0.48	0.32	0.16	0.08

OUNCES OF OIL

OUNCE-CC MEASUREMENTS

1/2	teaspoon	=	.083	oz =	2.46 cc
1	teaspoon	=	.167	oz =	4.93 cc
1/3	tablespoon	=	.167	oz =	4.93 cc
1/2	tablespoon	=	.25	oz =	7.39 cc
1	tablespoon	=	.5	oz =	14.79 cc
2	tablespoons	=	1.0	oz =	29.57 cc
1/4	cup	=	2	oz =	59.15 cc
1/3	cup	=	2.67	oz =	78.84 cc
1/2	cup	=	4	oz =	118.29 cc
2/3	cup	=	5.33	oz =	157.73 cc
3/4	cup	=	6	oz =	177.44 cc
1	cup	=	8	oz =	236.59 cc
1	pint	=	16	oz =	473.18 cc
1	quart	=	32	oz =	946.36 cc
2	quarts	=	64	oz =	1892.66 cc
3	quarts	=	96	oz =	2838.99 cc
1	gallon	=	128	oz =	3785.32 cc
1.5	gallons	=	192	oz =	5677.99 cc
2	gallons	=	256	oz =	7570.66 cc
3	gallons	=	384	oz =	11355.99 cc
4	gallons	=	512	oz =	15141.32 cc
4.5	gallons	=	576	oz =	17033.98 cc
5	gallons	=	640	oz =	18926.65 cc

RIGHT

SEE NOTE UNDER TITLE, PAGE 8

RECALCULATE TABLE

Decimal Equivalents of Millimeters

mm.	Inches	mm.	Inches	mm.	Inches	mm.	Inches	mm.	Inches
.01	.00039	.41	.01614	.81	.03189	21	.82677	61	2.40157
.02	.00079	.42	.01654	.82	.03228	22	.86614	62	2.44094
.03	.00118	.43	.01693	.83	.03268	23	.90551	63	2.48031
.04	.00157	.44	.01732	.84	.03307	24	.94488	64	2.51968
.05	.00197	.45	.01772	.85	.03346	25	.98425	65	2.55905
.06	.00236	.46	.01811	.86	.03386	26	1.02362	66	2.59842
.07	.00276	.47	.01850	.87	.03425	27	1.06299	67	2.63779
.08	.00315	.48	.01890	.88	.03465	28	1.10236	68	2.67716
.09	.00354	.49	.01929	.89	.03504	29	1.14173	69	2.71653
.10	.00394	.50	.01969	.90	.03543	30	1.18110	70	2.75590
.11	.00433	.51	.02008	.91	.03583	31	1.22047	71	2.79527
.12	.00472	.52	.02047	.92	.03622	32	1.25984	72	2.83464
.13	.00512	.53	.02087	.93	.03661	33	1.29921	73	2.87401
.14	.00551	.54	.02126	.94	.03701	34	1.33858	74	2.91338
.15	.00591	.55	.02165	.95	.03740	35	1.37795	75	2.95275
.16	.00630	.56	.02205	.96	.03780	36	1.41732	76	2.99212
.17	.00669	.57	.02244	.97	.03819	37	1.45669	77	3.03149
.18	.00709	.58	.02283	.98	.03858	38	1.49606	78	3.07086
.19	.00748	.59	.02323	.99	.03898	39	1.53543	79	3.11023
.20	.00787	.60	.02362	1.00	.03937	40	1.57480	80	3.14960
.21	.00827	.61	.02402	1	.03937	41	1.61417	81	3.18897
.22	.00866	.62	.02441	2	.07874	42	1.65354	82	3.22834
.23	.00906	.63	.02480	3	.11811	43	1.69291	83	3.26771
.24	.00945	.64	.02520	4	.15748	44	1.73228	84	3.30708
.25	.00984	.65	.02559	5	.19685	45	1.77165	85	3.34645
.26	.01024	.66	.02598	6	.23622	46	1.81102	86	3.38582
.27	.01063	.67	.02638	7	.27559	47	1.85039	87	3.42519
.28	.01102	.68	.02677	8	.31496	48	1.88976	88	3.46456
.29	.01142	.69	.02717	9	.35433	49	1.92913	89	3.50393
.30	.01181	.70	.02756	10	.39370	50	1.96850	90	3.54320
.31	.01220	.71	.02795	11	.4330	51	2.00787	91	3.58267
.32	.01260	.72	.02835	12	.47244	52	2.04724	92	3.62204
.33	.01299	.73	.02874	13	.51181	53	2.08661	93	3.66141
.34	.01339	.74	.02913	14	.55118	54	2.12598	94	3.70078
.35	.01378	.75	.02953	15	.59055	55	2.16535	95	3.74015
.36	.01417	.76	.02992	16	.62992	56	2.20472	96	3.77952
.37	.01457	.77	.03032	17	.66929	57	2.24409	97	3.81889
.38	.01496	.78	.03071	18	.70866	58	2.28346	98	3.85826
.39	.01535	.79	.03110	19	.74803	59	2.32283	99	3.89763
.40	.01575	.80	.03150	20	.78740	60	2.36220	100	3.93700

RIGHT

3

FLUID OUNCE-CUBIC CENTIMETER EQUIVALENTS

fl. oz.		cc	cc		fl. oz.
.01	=	.2957	1	=	.0338
.02	=	.5915	2	=	.0676
.03	=	.8872	3	=	.1014
.04	=	1.1829	4	=	.1353
.05	=	1.4787	5	=	.1691
.06	=	1.7744	6	=	.2029
.07	=	2.0702	7	=	.2367
.08	=	2.3659	8	=	.2705
.09	=	2.6616	9	=	.3043
.10	=	2.9574	10	=	.3381
.2	=	5.9147	20	=	.6763
.3	=	8.8721	30	=	1.0144
.4	=	11.8295	40	=	1.3526
.5	=	14.7869	50	=	1.6907
.6	=	17.7442	60	=	2.0288
.7	=	20.7016	70	=	2.3670
.8	=	23.6590	80	=	2.7051
.9	=	26.6164	90	=	3.0433
1.0	=	29.574	100	=	3.381
2	=	59.147	200	=	6.763
3	=	88.721	300	=	10.144
4	=	118.295	400	=	13.526
5	=	147.869	500	=	16.907
6	=	177.442	600	=	20.288
7	=	207.016	700	=	23.670
8	=	236.590	800	=	27.051
9	=	266.164	900	=	30.433
10	=	295.737	1000	=	33.814
20	=	591.475	2000	=	67.628
30	=	887.212	3000	=	101.442
40	=	1182.949	4000	=	135.256
50	=	1478.687	5000	=	169.070
60	=	1774.424	6000	=	202.884
70	=	2070.161	7000	=	236.698
80	=	2365.898	8000	=	270.512
90	=	2661.636	9000	=	304.326
100	=	2957.373	10000	=	338.140

LEFT

CUBIC INCH-CUBIC CENTIMETER EQUIVALENTS

cu. in.		cc
.001	=	.0164
.002	=	.0328
.003	=	.0492
.004	=	.0655
.005	=	.0819
.006	=	.0983
.007	=	.1147
.008	=	.1311
.009	=	.1475
.010	=	.1639
.02	=	.3277
.03	=	.4916
.04	=	.6555
.05	=	.8194
.06	=	.9832
.07	=	1.1471
.08	=	1.3110
.09	=	1.4748
.10	=	1.6387
.2	=	3.2774
.3	=	4.9161
.4	=	6.5548
.5	=	8.1935
.6	=	9.8322
.7	=	11.4709
.8	=	13.1097
.9	=	14.7484
1.0	=	16.387
2	=	32.774
3	=	49.161
4	=	65.548
5	=	81.935
6	=	98.322
7	=	114.709
8	=	131.097
9	=	147.484
10	=	163.871
20	=	327.741
30	=	491.612
40	=	655.483
50	=	819.353
60	=	983.224
70	=	1147.094
80	=	1310.965
90	=	1474.836
100	=	1638.706
200	=	3277.413
300	=	4916.119
400	=	6554.826
500	=	8193.532
600	=	9832.238
700	=	11470.945
800	=	13109.651
900	=	14748.358
1000	=	16387.064

cc		cu. in.
.01	=	.0006
.02	=	.0012
.03	=	.0018
.04	=	.0024
.05	=	.0031
.06	=	.0037
.07	=	.0043
.08	=	.0049
.09	=	.0055
.10	=	.0061
.2	=	.0122
.3	=	.0183
.4	=	.0244
.5	=	.0305
.6	=	.0366
.7	=	.0427
.8	=	.0488
.9	=	.0549
1.0	=	.0610
2	=	.1220
3	=	.1831
4	=	.2441
5	=	.3051
6	=	.3661
7	=	.4272
8	=	.4882
9	=	.5492
10	=	.610
20	=	1.220
30	=	1.831
40	=	2.441
50	=	3.051
60	=	3.661
70	=	4.272
80	=	4.882
90	=	5.492
100	=	6.102
200	=	12.205
300	=	18.307
400	=	24.409
500	=	30.512
600	=	36.614
700	=	42.717
800	=	48.819
900	=	54.921
1000	=	61.024
2000	=	122.047
3000	=	183.071
4000	=	244.095
5000	=	305.119
6000	=	366.142
7000	=	427.166
8000	=	488.190
9000	=	549.214
10000	=	610.237

RIGHT

5

INCH-MILLIMETER EQUIVALENTS

in.		mm	mm		in.
.0001	=	.00254	.01	=	.0003937
.0002	=	.00508	.02	=	.0007874
.0003	=	.00762	.03	=	.0011811
.0004	=	.01016	.04	=	.0015748
.0005	=	.01270	.05	=	.0019685
.0006	=	.01524	.06	=	.0023622
.0007	=	.01778	.07	=	.0027559
.0008	=	.02032	.08	=	.0031496
.0009	=	.02286	.09	=	.0035433
.0010	=	.02540	.10	=	.0039370
.002	=	.0508	.2	=	.007874
.003	=	.0762	.3	=	.011811
.004	=	.1016	.4	=	.015748
.005	=	.1270	.5	=	.019685
.006	=	.1524	.6	=	.023622
.007	=	.1778	.7	=	.027559
.008	=	.2032	.8	=	.031496
.009	=	.2286	.9	=	.035433
.010	=	.2540	1.0	=	.039370
.02	=	.508	2	=	.07874
.03	=	.762	3	=	.11811
.04	=	1.016	4	=	.15748
.05	=	1.270	5	=	.19685
.06	=	1.524	6	=	.23622
.07	=	1.778	7	=	.27559
.08	=	2.032	8	=	.31496
.09	=	2.286	9	=	.35433
.10	=	2.540	10	=	.39370
.2	=	5.08	20	=	.7874
.3	=	7.62	30	=	1.1811
.4	=	10.16	40	=	1.5748
.5	=	12.70	50	=	1.9685
.6	=	15.24	60	=	2.3622
.7	=	17.78	70	=	2.7559
.8	=	20.32	80	=	3.1496
.9	=	22.86	90	=	3.5433
1.0	=	25.40	100	=	3.9370
2	=	50.8	200	=	7.874
3	=	76.2	300	=	11.811
4	=	101.6	400	=	15.748
5	=	127.0	500	=	19.685
6	=	152.4	600	=	23.622
7	=	177.8	700	=	27.559
8	=	203.2	800	=	31.496
9	=	228.6	900	=	35.433
10	=	254.0	1000	=	39.370
20	=	508.0	2000	=	78.74
30	=	762.0	3000	=	118.11
40	=	1016.0	4000	=	157.48
50	=	1270.0	5000	=	196.85
60	=	1524.0	6000	=	236.22
70	=	1778.0	7000	=	275.59
80	=	2032.0	8000	=	314.96
90	=	2286.0	9000	=	354.33
100	=	2540.0	10000	=	393.70

LEFT

FRACTIONAL-DECIMAL-METRIC EQUIVALENTS OF ONE INCH

(Based on 1 inch = 25.4mm exactly
Thus, 1mm = 0.03937008 inch, exactly)

8 ths	16 ths	32 nds	64 ths	128 ths	INCH	MILLI-METERS
					.003937008 -----	.1
				1-----	.0078125	.1984375
					.007874016 -----	.2
					.011811024 -----	.3
			1----------		.015625	.396875
					.015748032 -----	.4
					.01968504 -----	.5
				3-----	.0234375	.5953125
					.023622048 -----	.6
					.027559056 -----	.7
		1----------			.03125	.79375
					.031496064 -----	.8
					.035433072 -----	.9
				5-----	.0390625	.9921875
					.03937008 ----	1.0
					.043307088 ----	1.1
			3----------		.046875	1.190625
					.047244096 ----	1.2
					.051181104 ----	1.3
				7-----	.0546875	1.3890625
					.055118112 ----	1.4
					.05905512 ----	1.5
	1----------				.0625	1.5875
					.062992128 ----	1.6
					.066929136 ----	1.7
				9-----	.0703125	1.7859375
					.070866144 ----	1.8
					.074803152 ----	1.9
			5----------		.078125	1.984375
					.07874016 ----	2.0
					.082677168 ----	2.1
				11----	.0859375	2.1828125
					.086614176 ----	2.2
					.090551184 ----	2.3
		3----------			.09375	2.38125
					.094488192 ----	2.4
					.0984252 ----	2.5
				13----	.1015625	2.5796875
					.10236221 ----	2.6
					.10629922 ----	2.7
			7----------		.109375	2.778125
					.11023622 ----	2.8
					.11417323 ----	2.9
				15----	.1171875	2.9765625
					.11811024 ----	3.0
					.12204725 ----	3.1
1----------					.125	3.175
					.12598425 ----	3.2
					.12992126 ----	3.3

(continued on next page)

(continued from preceding page)

8 ths	16 ths	32 nds	64 ths	128 ths	INCH		MILLI-METERS
				17----	.1328125		3.3734375
					.13385827	----	3.4
					.13779528	----	3.5
			9----------		.140625		3.571875
					.14173229	----	3.6
					.1456693	----	3.7
				19----	.1484375		3.7703125
					.1496063	----	3.8
					.15354331	----	3.9
		5----------			.15625		3.96875
					.15748032	----	4.0
					.16141733	----	4.1
				21----	.1640625		4.1671875
					.16535434	----	4.2
					.16929134	----	4.3
			11----------		.171875		4.365625
					.17322835	----	4.4
					.17716536	----	4.5
				23----	.1796875		4.5640625
					.18110237	----	4.6
					.18503938	----	4.7
	3----------				.1875		4.7625
					.18897638	----	4.8
					.19291339	----	4.9
				25----	.1953125		4.9609375
					.1968504	----	5.0
					.20078741	----	5.1
			13----------		.203125		5.159375
					.20472442	----	5.2
					.20866142	----	5.3
				27----	.2109375		5.3578125
					.21259843	----	5.4
					.21653544	----	5.5
		7----------			.21875		5.55625
					.22047245	----	5.6
					.22440946	----	5.7
				29----	.2265625		5.7546875
					.22834646	----	5.8
					.23228347	----	5.9
			15----------		.234375		5.953125
					.23622048	----	6.0
					.24015749	----	6.1
				31----	.2421875		6.1515625
					.2440945	----	6.2
					.2480315	----	6.3
1/4----------					.25		6.35
					.25196851	----	6.4
					.25590552	----	6.5
				33----	.2578125		6.5484375
					.25984253	----	6.6
					.26377954	----	6.7
			17----------		.265625		6.746875
					.26771654	----	6.8
					.27165355	----	6.9

8 ths	16 ths	32 nds	64 ths	128 ths	INCH	MILLI-METERS
				35----	.2734375	6.9453125
					.27559056 ----	7.0
					.27952757 ----	7.1
		9----------			.28125	7.14375
					.28346458 ----	7.2
					.28740158 ----	7.3
				37----	.2890625	7.3421875
					.29133859 -----	7.4
					.2952756 -----	7.5
			19----------		.296875	7.540625
					.29921261 -----	7.6
					.30314962 -----	7.7
				39----	.3046875	7.7390625
					.30708662 -----	7.8
					.31102363 -----	7.9
	5----------				.3125	7.9375
					.31496064 -----	8.0
					.31889765 -----	8.1
				41----	.3203125	8.1359375
					.32283466 -----	8.2
					.32677166 -----	8.3
			21----------		.328125	8.334375
					.33070867 -----	8.4
					.33464568 -----	8.5
				43----	.3359375	8.5328125
					.33858269 -----	8.6
					.3425197 -----	8.7
		11----------			.34375	8.73125
					.3464567 -----	8.8
					.35039371 -----	8.9
				45----	.3515625	8.9296875
					.35433072 -----	9.0
					.35826773 -----	9.1
			23----------		.359575	9.128125
					.36220474 -----	9.2
					.36614174 -----	9.3
				47----	.3671875	9.3265625
					.37007875 -----	9.4
					.37401576 -----	9.5
3----------					.375	9.525
					.37795277 -----	9.6
					.38188978 -----	9.7
				49----	.3828125	9.7234375
					.38582678 -----	9.8
					.38976379 -----	9.9
			25----------		.390625	9.921875
					.3937008 ----	10.0
					.39763781 ----	10.1
				51----	.3984375	10.120313
					.40157482 ----	10.2
					.40551183 ----	10.3
		13----------			.40625	10.31875
					.40944883 ----	10.4
					.41338584 ----	10.5
				53----	.4140625	10.517188
					.41732285 ----	10.6

(continued on next page)

RIGHT

(continued from preceding page)

8 ths	16 ths	32 nds	64 ths	128 ths	INCH	MILLI-METERS
					.42125986 ----	10.7
			27----------		.421875	10.715625
					.42519687 ----	10.8
					.42913387 ----	10.9
				55----	.4296875	10.914063
					.43307088 ----	11.0
					.43700789 ----	11.1
	7----------				.4375	11.1125
					.4409449 ----	11.2
					.44488191 ----	11.3
				57----	.4453125	11.310938
					.44881891 ----	11.4
					.45275592 ----	11.5
			29----------		.453125	11.509375
					.45669293 ----	11.6
					.46062994 ----	11.7
				59----	.4609375	11.707818
					.46456695 ----	11.8
					.46850395 ----	11.9
		15----------			.46875	11.90625
					.47244096 ----	12.0
					.47637797 ----	12.1
				61----	.4765625	12.104688
					.48031498 ----	12.2
					.48425199 ----	12.3
			31----------		.484375	12.303125
					.48818899 ----	12.4
					.492126 ----	12.5
				63----	.4921875	12.501563
					.49606301 ----	12.6
	1/2----------				.5	12.7
					.50393703 ----	12.8
				65----	.5078125	12.898438
					.50787405 ----	12.9
					.51181104 ----	13.0
			33----------		.515625	13.096875
					.51574805 ----	13.1
					.51968506 ----	13.2
				67----	.5234375	13.295313
					.52362207 ----	13.3
					.52755908 ----	13.4
		17----------			.53125	13.49375
					.53149608 ----	13.5
					.53543309 ----	13.6
				69----	.5390625	13.692188
					.5393701 ----	13.7
					.54330711 ----	13.8
			35----------		.546875	13.890625
					.54724412 ----	13.9
					.55118112 ----	14.0
				71----	.5546875	14.089063
					.55511813 ----	14.1
					.55905514 ----	14.2
	9----------				.5625	14.2875

8 ths	16 ths	32 nds	64 ths	128 ths	INCH	MILLI-METERS
					.56299215 ----	14.3
					.56692916 ----	14.4
				73----	.5703125	14.485938
					.57086616 ----	14.5
					.57480317 ----	14.6
			37----------		.578125	14.684375
					.57874018 ----	14.7
					.58267719 ----	14.8
				75----	.5859375	14.882813
					.5866142 ----	14.9
					.5905512 ----	15.0
		19----------			.59375	15.08125
					.59448821 ----	15.1
					.59842522 ----	15.2
				77----	.6015625	15.279688
					.60236223 ----	15.3
					.60629924 ----	15.4
			39----------		.609375	15.478125
					.61023624 ----	15.5
					.61417325 ----	15.6
				79----	.6171875	15.676563
					.61811026 ----	15.7
					.62204727 ----	15.8
5----------					.625	15.875
					.62598428 ----	15.9
					.62992128 ----	16.0
				81----	.6328125	16.073438
					.63385829 ----	16.1
					.6377953 ----	16.2
			41----------		.640625	16.271875
					.64173231 ----	16.3
					.64566932 ----	16.4
				83----	.6484375	16.470313
					.64960633 ----	16.5
					.65354333 ----	16.6
		21----------			.65625	16.66875
					.65748034 ----	16.7
					.66141735 ----	16.8
				85----	.6640625	16.867188
					.66535436 ----	16.9
					.66929137 ----	17.0
			43----------		.671875	17.065625
					.67322837 ----	17.1
					.67716538 ----	17.2
				87----	.6796875	17.264063
					.68110239 ----	17.3
					.6850394 ----	17.4
	11----------				.6875	17.4625
					.68897641 ----	17.5
					.69291341 ----	17.6
				89----	.6953125	17.660938
					.69685042 ----	17.7
					.70078743 ----	17.8
			45----------		.703125	17.859375
					.70472444 ----	17.9
					.70866145 ----	18.0

(continued on next page)

RIGHT

(continued from preceding page)

8 ths	16 ths	32 nds	64 ths	128 ths	INCH	MILLI-METERS
				91----	.7109375	18.057813
					.71259645 ----	18.1
					.71653546 ----	18.2
		23----------			.71875	18.25625
					.72047247 ----	18.3
					.72440948 ----	18.4
				93----	.7265625	18.454688
					.72834649 ----	18.5
					.73228349 ----	18.6
			47----------		.734375	18.653125
					.7362205 ----	18.7
					.74015751 ----	18.8
				95----	.7421875	18.851563
					.74409452 ----	18.9
					.74803153 ----	19.0
3/4----------					.75	19.05
					.75196853 ----	19.1
					.75590554 ----	19.2
				97----	.7578125	19.248438
					.75984255 ----	19.3
					.76377956 ----	19.4
			49----------		.765625	19.446875
					.76771657 ----	19.5
					.77165358 ----	19.6
				99----	.7734375	19.645313
					.77559058 ----	19.7
					.77952759 ----	19.8
		25----------			.78125	19.84375
					.7834646 ----	19.9
					.78740161 ----	20.0
				101---	.7890625	20.042188
					.79133862 ----	20.1
					.79527562 ----	20.2
			51----------		.796875	20.240625
					.79921263 ----	20.3
					.80314964 ----	20.4
				103---	.8046875	20.439063
					.80708665 ----	20.5
					.81102366 ----	20.6
	13----------				.8125	20.6375
					.81496066 ----	20.7
					.81889767 ----	20.8
				105---	.8203125	20.835938
					.82283468 ----	20.9
					.82677169 ----	21.0
			53----------		.828125	21.034375
					.8307087 ----	21.1
					.8346457 ----	21.2
				107---	.8359375	21.232813
					.83858271 ----	21.3
					.84251972 ----	21.4
		27----------			.84375	21.43125
					.84645673 ----	21.5
					.85039374 ----	21.6

8 ths	16 ths	32 nds	64 ths	128 ths	INCH	MILLI-METERS
				109---	.8515625	21.629688
					.85433074 ----	21.7
					.85826775 ----	21.8
			55----------		.859375	21.828125
					.86220476 ----	21.9
					.86614177 ----	22.0
				111---	.8671875	22.026563
					.87007878 ----	22.1
					.87401578 ----	22.2
7----------					.875	22.225
					.87795279 ----	22.3
					.8818898 ----	22.4
				113---	.8828125	22.423438
					.88582681 ----	22.5
					.88976382 ----	22.6
			57----------		.890625	22.621875
					.89370083 ----	22.7
					.89763783 ----	22.8
				115---	.8984375	22.820313
					.90157484 ----	22.9
					.90551185 ----	23.0
		29----------			.90625	23.01875
					.90944886 ----	23.1
					.91338587 ----	23.2
				117---	.9140625	23.217188
					.91732287 ----	23.3
					.92125988 ----	23.4
			59----------		.921875	23.415625
					.92519689 ----	23.5
					.9291339 ----	23.6
				119---	.9296875	23.614063
					.93307091 ----	23.7
					.93700791 ----	23.8
	11----------				.9375	23.8125
					.94094492 ----	23.9
					.94488193 ----	24.0
				121---	.9453125	24.010938
					.94881894 ----	24.1
					.95275595 ----	24.2
			61----------		.953125	24.209375
					.95669295 ----	24.3
					.96062996 ----	24.4
				123---	.9609375	24.407813
					.96456697 ----	24.5
					.96850398 ----	24.6
		31----------			.96875	24.60625
					.97244099 ----	24.7
					.97637799 ----	24.8
				125---	.9765625	24.804688
					.980315 ----	24.9
					.98425201 ----	25.0
			63----------		.984375	25.003125
					.98818902 ----	25.1
					.99212603 ----	25.2
				127---	.9921875	25.201563
					.99606303 ----	25.3
1 INCH----------					1.0 ----	25.4

RIGHT

1/3 15

INCHES IN DECIMALS OF A FOOT

INCHES	FOOT	INCHES	FOOT	INCHES	FOOT	INCHES	FOOT
1/32 =	.00260	3/8 =	.03125	23/32 =	.05990	3 =	.25000
1/16 =	.00521	13/32 =	.03385	3/4 =	.06250	4 =	.33333
3/32 =	.00781	7/16 =	.03646	25/32 =	.06510	5 =	.41667
1/8 =	.01042	15/32 =	.03906	13/16 =	.06771	6 =	.50000
5/32 =	.01302	1/2 =	.04167	27/32 =	.07031	7 =	.58333
3/16 =	.01563	17/32 =	.04427	7/8 =	.07292	8 =	.66667
7/32 =	.01823	9/16 =	.04688	29/32 =	.07552	9 =	.75000
1/4 =	.02083	19/32 =	.04948	15/16 =	.07813	10 =	.83333
9/32 =	.02344	5/8 =	.05208	31/32 =	.08073	11 =	.91667
5/16 =	.02604	21/32 =	.05469	1 =	.08333	12 =	1.00000
11/32 =	.02865	11/16 =	.05729	2 =	.16667		

TWIST DRILL NUMBER & LETTER SIZE INCH-DECIMAL EQUIVALENTS

#	DEC.	#	DEC.	#	DEC.	#	DEC.	LTR.	DEC.	LTR.	DEC.
80 =	.0135	60 =	.040	40 =	.098	20 =	.161				
79 =	.0145	59 =	.041	39 =	.0995	19 =	.166				
78 =	.016	58 =	.042	38 =	.1015	18 =	.1695				
77 =	.018	57 =	.043	37 =	.104	17 =	.173	A =	.234	N =	.302
76 =	.020	56 =	.0465	36 =	.1065	16 =	.177	B =	.238	O =	.316
75 =	.021	55 =	.052	35 =	.110	15 =	.180	C =	.242	P =	.323
74 =	.0225	54 =	.055	34 =	.111	14 =	.182	D =	.246	Q =	.332
73 =	.024	53 =	.0595	33 =	.113	13 =	.185	E =	.250	R =	.339
72 =	.025	52 =	.0635	32 =	.116	12 =	.189	F =	.257	S =	.348
71 =	.026	51 =	.067	31 =	.120	11 =	.191	G =	.261	T =	.358
70 =	.028	50 =	.070	30 =	.1285	10 =	.1935	H =	.266	U =	.368
69 =	.02925	49 =	.073	29 =	.136	9 =	.196	I =	.272	V =	.377
68 =	.031	48 =	.076	28 =	.1405	8 =	.199	J =	.277	W =	.386
67 =	.032	47 =	.0785	27 =	.144	7 =	.201	K =	.281	X =	.397
66 =	.033	46 =	.081	26 =	.147	6 =	.204	L =	.290	Y =	.404
65 =	.035	45 =	.082	25 =	.1495	5 =	.2055	M =	.295	Z =	.413
64 =	.036	44 =	.086	24 =	.152	4 =	.209				
63 =	.037	43 =	.089	23 =	.154	3 =	.213				
62 =	.038	42 =	.0935	22 =	.157	2 =	.221				
61 =	.039	41 =	.096	21 =	.159	1 =	.228				

LEFT

TAP AND DRILL SIZES

NOMINAL TAP SIZE					RECOMMENDED DRILL SIZE FOR APPROX. 75% THREADS
METRIC	BRITISH STANDARD FINE	BRITISH STANDARD WHITWORTH	BRITISH ASSOCIATION STANDARD	AMERICAN UNIFIED NC (COARSE) & NF (FINE)	
.40-.100	-	-	-	-----	#80
.45-.100	-	-	-	-----	#79
.50-.125	-	-	-	-----	1/64
.55-.125	-	-	-	-----	#77
.60-.150	-	-	-	-----	#77
.70-.175	-	-	-	-----	#74
-	-	-	#16-133.3	-----	#73
.80-.200	-	-	-	-----	#72
.90-.225	-	-	#15-120.5	-----	#70
1-.25	-	-	-	-----	#68
1-.20	-	-	#14-109.9	-----	#67
1.1-.25	-	-	-	-----	#65
1.2-.25	-	-	#13-102.0	-----	#62
1.2-.20	-	-	-	-----	#60
-	-	-	#12-90.9	-----	#58
1.4-.30	-	-	-	# 0-80 -----	3/64
1.4-.20	-	-	#11-81.9	-----	#55
1.5-.30	-	-	-	-----	#55
1.6-.35	-	-	-	-----	#55
1.7-.35	-	-	-	-----	#55
1.7-.20	-	-	#10-72.6	# 1-64 -----	#53
1.8-.35	-	-	-	# 1-72 -----	#53
-	-	-	# 9-65.1	-----	1/16
2-.40	-	-	-	-----	#52
2-.25	-	-	-	# 2-56 -----	#50
2.2-.45	-	-	-	# 2-64 -----	#50
-	-	-	# 8-59.1	-----	#49
2.3-.40	-	-	-	-----	#48
-	-	-	-	# 3-48 -----	#47
2.3-.25	-	-	# 7-52.9	-----	#46
2.5-.45	-	-	-	-----	#46
-	-	-	-	# 3-56 -----	#45
2.6-.45	-	-	-	-----	#44
2.6-.35	-	-	-	# 4-40 -----	#43
-	-	-	# 6-47.9	# 4-48 -----	#42
3-.60	-	-	-	-----	#41
3-.50	-	-	-	-----	#39
-	-	1/8-40	-	# 5-40 -----	#38
3-.35	-	-	# 5-43.0	# 5-44 -----	#37
-	-	-	-	# 6-32 -----	#36
-	-	-	-	# 6-40 -----	#33
3.5-.60	-	-	-	-----	#32

(continued on next page)

RIGHT

(continued from preceding page)

NOMINAL TAP SIZE					RECOMMENDED DRILL SIZE FOR APPROX. 75% THREADS
METRIC	BRITISH STANDARD FINE	BRITISH STANDARD WHITWORTH	BRITISH ASSOCIATION STANDARD	AMERICAN UNIFIED NC (COARSE) & NF (FINE)	
-	-	5/32-32	# 4-38.5	-----	#31
3.5-.35	-	-	-	-----	1/8
4-.75	-	-	-	-----	#30
4-.70	-	-	-	-----	#30
-	-	-	# 3-34.8	# 8-32 -----	#29
-	-	-	-	# 8-36 -----	#29
4-.50	-	-	-	-----	#28
-	-	3/16-24	-	-----	#26
4.5-.75	-	-	-	#10-24 -----	#25
-	3/16-32	-	-	-----	5/32
4.5-.50	-	-	# 2-31.4	#10-32 -----	#21
5-.90	-	-	-	-----	#20
5-.80	-	-	-	-----	#19
5-.75	-	-	-	-----	#18
-	-	7/32-24	-	-----	11/64
5-.50	-	-	# 1-28.2	#12-24 -----	#16
5.5-.90	-	-	-	#12-28 -----	#14
-	7/32-28	-	-	-----	#13
6-1.00	-	-	-	-----	# 9
-	-	1/4-20	# 0-25.4	1/4-20 -----	# 7
6-.75	1/4-26	-	-	-----	# 4
-	-	-	-	1/4-28 -----	# 3
6-.50	-	-	-	-----	7/32
7-1.00	9/32-26	-	-	-----	B
7-.75	-	-	-	-----	D
7-.50	-	5/16-18	-	5/16-18 -----	F
8-1.25	-	-	-	-----	17/64
-	5/16-22	-	-	-----	H
-	-	-	-	5/16-24 -----	I
8-1.00	-	-	-	-----	J
8-.75	-	-	-	-----	L
9-1.25	-	3/8-16	-	3/8-16 -----	5/16
9-1.00	-	-	-	-----	O
9-.75	3/8-20	-	-	-----	21/64
-	-	-	-	3/8-24 -----	Q
10-1.50	-	-	-	-----	R
10-1.25	-	-	-	-----	S
10-1.00	-	-	-	-----	T
10-.75	-	7/16-14	-	7/16-14 -----	U
11-1.50	-	-	-	-----	3/8
11-1.25	7/16-18	-	-	-----	W
-	-	-	-	7/16-20 -----	25/64
11-1.00	-	-	-	-----	X
11-.75	-	-	-	-----	Y
12-1.75	-	-	-	-----	Y

NOMINAL TAP SIZE				RECOMMENDED DRILL SIZE FOR APPROX. 75% THREADS
METRIC	BRITISH STANDARD FINE	BRITISH STANDARD WHITWORTH	BRITISH ASSOCIATION STANDARD	AMERICAN UNIFIED NC (COARSE) & NF (FINE)	
12-1.50				-----	Z
12-1.25		1/2-12		1/2-13	----- 27/64
12-1.00	1/2-16				----- 7/16
				1/2-20	----- 29/64
14-2.00		9/16-12		9/16-12	----- 31/64
14-1.50	9/16-16				----- 1/2
14-1.25					----- 1/2
14-1.00				9/16-18	----- 33/64
		5/8-11		5/8-11	----- 17/32
16-2.00	5/8-14				----- 9/16
16-1.50				5/8-18	----- 37/64
16-1.25		11/16-11			----- 19/32
16-1.00					----- 19/32
18-2.50	11/16-14				----- 39/64
18-2.00					----- 5/8
		3/4-10			----- 41/64
18-1.50				3/4-10	----- 21/32
18-1.00	3/4-12				----- 43/64
20-2.50				3/4-16	----- 11/16
		13/16-10			----- 45/64
20-2.00	13/16-12				----- 23/32
20-1.50					----- 47/64
20-1.25					----- 47/64
20-1.00					----- 3/4
22-2.50		7/8-9		7/8-9	----- 49/64
	7/8-11				----- 25/32
22-2.00					----- 51/64
22-1.50		15/16-9		7/8-14	----- 13/16
22-1.00					----- 53/64
24-3.00					----- 53/64
24-2.00		1-8		1-8	----- 7/8
24-1.50					----- 57/64
25-2.00	1-10				----- 29/32
				1-12	----- 59/64
25-1.50				1-14	----- 15/16
25-1.00					----- 61/64
26-1.50					----- 31/32

INTERRELATION OF UNITS OF MEASUREMENTS

(LENGTHS)

1 inch =

0.083333	foot
0.027777	yard
25.4	millimeters
2.54	centimeters
0.0254	meter

1 foot =

12.0	inches
0.33333	yard
0.000189393	mile
304.8	millimeters
30.48	centimeters
0.3048	meter

1 yard =

36.0	inches
3.0	feet
914.4	millimeters
91.44	centimeters
0.9144	meter

1 mile =

63360.0	inches
5280.0	feet
1760.0	yards
160934.4	centimeters
1609.344	meters
1.609344	kilometers

1 millimeter =

0.039370079	inch
0.00328084	foot
0.0010936	yard
0.1	centimeter
0.001	meter

1 centimeter =

0.39370079	inch
0.0328084	foot
0.010936	yard
10.0	millimeters
0.01	meter

1 meter =

39.370079	inches
3.2808399	feet
1.0936133	yards
0.00062137	mile
1000.0	millimeters
100.0	centimeters

1 kilometer =

39370.079	inches
3280.8399	feet
1093.6133	yards
0.62137119	mile
100000.0	centimeters
1000.0	meters

(AREAS)

1 square inch =

0.00069444	sq. foot
0.0007716	sq. yard
645.16	sq. millimeters
6.4516	sq. centimeters
0.00064516	sq. meter

1 square foot =

144.0	sq. inches
0.11111	sq. yard
92903.04	sq. millimeters
929.0304	sq. centimeters
0.09290304	sq. meter

1 square yard =

1296.0	sq. inches
9.0	sq. feet
836127.36	sq. millimeters
8361.2736	sq. centimeters
0.83612736	sq. meter

1 square millimeter =

0.001550003	sq. inch
0.000010764	sq. foot
0.01	sq. centimeter
0.000001	sq. meter

1 square centimeter =

0.1550003	sq. inch
0.00107639	sq. foot
100.0	sq. millimeters
0.0001	sq. meter

1 square meter =

1550.0031	sq. inches
10.76391	sq. feet
1.19599	sq. yards
1000000.0	sq. millimeters
10000.0	sq. centimeters

(VOLUMES)

1 cubic inch =

0.000578704	cu. foot
0.000021433	cu. yard
16387.064	cu. millimeters
16.387064	cu. centimeters
0.000016387	cu. meter

cubic foot =

1728.0	cu. inches
0.037037	cu. yard
28316.847	cu. centimeters
0.028316847	cu. meter
7.4805195	gallons
28.31605	liters

1 cubic millimeter =

0.000061024	cu. inch
0.000000035	cu. foot
0.001	cu. centimeter
0.000000001	cu. meter

1 cubic centimeter =

0.06102374	cu. inch
0.000035315	cu. foot
1000.0	cu. millimeters
0.000001	cu. meter

(LIQUID MEASURES)

1 fluid dram =		
	0.125	fl. ounce
	0.0078125	liq. pint
	0.00390625	liq. quart
	0.00097656	gallon
	3.696588	milliliters
	0.003696588	liter
	0.225586	cu. inch
1 fluid ounce =		
	8.0	fl. drams
	0.0625	liq. pint
	0.03125	liq. quart
	0.0078125	gallon
	29.572702	milliliters
	0.0295727	liter
	1.8046875	cu. inches
1 liquid pint =		
	128.0	fl. drams
	16.0	fl. ounces
	0.5	liq. quart
	0.125	gallon
	473.1632	milliliters
	0.4731632	liter
	28.875	cu. inches
1 liquid quart =		
	256.0	fl. drams
	32.0	fl. ounces
	2.0	liq. pints
	0.25	gallon
	946.3264	milliliters
	0.9463264	liter
	57.75	cu. inches
1 gallon =		
	1024.0	fl. drams
	128.0	fl. ounces
	8.0	liq. pints
	4.0	liq. quarts
	3785.306	milliliters
	3.785306	liters
	231.0	cu. inches
1 milliliter =		
	0.2705198	fl. dram
	0.03381497	fl. ounce
	0.002113436	liq. pint
	0.001056718	liq. quart
	0.000264179	gallon
	0.001	liter
	0.06102545	cu. inch
1 liter =		
	270.5198	fl. drams
	33.81497	fl. ounces
	2.113436	liq. pints
	1.056718	liq. quarts
	0.2641794	gallon
	1000.0	milliliters
	61.02545	cu. inches
	0.03531566	cu. foot

(DRY MEASURES)

1 grain =		
	0.03657143	avdp. dram
	0.00228571	avdp. ounce
	0.000142857	avdp. pound
	64.79891	milligrams
	0.06479891	gram
	0.000064799	kilogram
1 avoirdupois dram =		
	27.34375	grains
	0.0625	avdp. ounce
	0.00390625	avdp. pound
	1771.845195	milligrams
	1.7718452	grams
	0.001771845	kilogram
1 avoirdupois ounce =		
	437.5	grains
	16.0	avdp. drams
	0.0625	avdp. pound
	28349.523	milligrams
	28.349523	grams
1 avoirdupois pound =		
	7000.0	grains
	256.0	avdp. drams
	16.0	avdp. ounces
	453592.37	milligrams
	453.59237	grams
	0.4535924	kilogram
1 milligram =		
	0.01543236	grain
	0.000564383	avdp. dram
	0.000035274	avdp. ounce
	0.000002205	avdp. pound
	0.001	gram
	0.000001	kilogram
1 gram =		
	15.432358	grains
	0.5643834	avdp. dram
	0.03527396	avdp. ounce
	0.002204623	avdp. pound
	1000.0	milligrams
	0.001	kilogram
1 kilogram =		
	15432.358	grains
	564.38339	avdp. drams
	35.273962	avdp. ounces
	2.2046226	avdp. pounds
	1000000.0	milligrams
	1000.0	grams

RIGHT

LENGTH-LIQUID-WEIGHT-VELOCITY EQUIVALENTS

MILLIMETER	CENTIMETER	INCH	FOOT	YARD	METER
1	.1	.03937	.003281	.001094	.001
10	1	.393701	.032808	.010936	.01
25.4	2.54	1	.083333	.027778	.0254
304.8	30.48	12	1	.333333	.3048
914.4	91.44	36	3	1	.9144
1000	100	39.370079	3.28084	1.093613	1

OUNCE	CUP	PINT	QUART	LITER	GALLON
1	.125	.0625	.03125	.029573	.007813
8	1	.5	.25	.236582	.0625
16	2	1	.5	.473163	.125
32	4	2	1	.946326	.25
33.81497	4.226872	2.113436	1.056718	1	.264179
128	16	8	4	3.785306	1

GRAIN	GRAM	DRAM	OUNCE	POUND	KILOGRAM
1	.064799	.036571	.002286	.000143	.000065
15.432358	1	.564383	.035274	.002205	.001
27.34375	1.771845	1	.0625	.003906	.001772
437.5	28.349523	16	1	.0625	.02835
7000	453.59237	256	16	1	.453592
15432.358	1000	564.38339	35.273962	2.204623	1

METERS PER HOUR	FEET PER MINUTE	KILOMETERS PER HOUR	FEET PER SECOND	MILES PER HOUR	METERS PER SECOND
1	.054681	.001	.000911	.000621	.000278
18.288	1	.018288	.016667	.011364	.00508
1000	54.680665	1	.911344	.621371	.277778
1097.28	60	1.09728	1	.681818	.3048
1609.344	88	1.609344	1.466667	1	.44704
3600	196.85039	3.6	3.28084	2.236936	1

MOVE TO HERE

METRIC-ENGLISH CONVERSION TABLES

TO OBTAIN:	MULTIPLY:	BY:
(LENGTHS)		
Millimeters.....(mm)	Inches.....	25.4
Millimeters	Meters	1000
Centimeters.....(cm)	Inches.....	2.54
Centimeters	Meters	100
Meters.....(m)	Inches.....	.0254
Meters	Feet	.3048
Meters	Yards	.9144
Meters	Miles	1609.344
Meters	Millimeters	.001
Meters	Centimeters	.01
Meters	Kilometers	1000
Kilometers.....(km)	Miles.....	1.60934
Kilometers	Meters	.001
Inches.....(in.)	Millimeters.....	.03937
Inches	Centimeters	.3937
Inches	Meters	39.37008
Inches	Feet	12
Feet.....(ft.)	Meters.....	3.28084
Feet	Inches	.083333
Feet	Miles	5280
Yards.....(yd.)	Meters.....	1.093613
Yards	Miles	1760
Miles.....(mi.)	Meters.....	.00062137
Miles	Kilometers	.62137
Miles	Feet	.00018939
Miles	Yards	.00056817
Miles (statute)	Nautical Miles	1.15078
Nautical Miles.....(naut. mi.)	Miles (statute).....	.86898
(AREAS)		
Square Millimeters.....(mm^2)	Square Inches.....	645.16
Square Millimeters	Square Centimeters	100
Square Centimeters.....(cm^2)	Square Inches.....	6.4516
Square Centimeters	Square Millimeters	.01
Square Meters.....(m^2)	Square Inches.....	.00064516
Square Meters	Square Feet	.092903
Square Meters	Square Yards	.83613
Square Meters	Square Centimeters	.0001
Square Inches.....(sq. in.)	Square Millimeters.....	.00155
Square Inches	Square Centimeters	.155
Square Inches	Square Meters	1550.0031
Square Feet.....(sq. ft.)	Square Meters.....	10.76391
Square Feet	Square Inches	.0069444
Square Yards.....(sq. yd.)	Square Meters.....	1.19599

(BASED ON 1 INCH = 25.4, EXACTLY; THUS, 1 MILLIMETER = 0.03937008 INCH, EXACTLY)

(continued on next page)

RIGHT

(continued from preceding page)

TO OBTAIN:	MULTIPLY:	BY:
(VOLUMES)		
ıbic Millimeters.....(mm³)	Cubic Inches.....	16387.064
Cubic Millimeters	Cubic Centimeters	1000
Cubic Centimeters.....(cc)or(cm³)	Cubic Inches.....	16.38706
Cubic Centimeters	Cubic Millimeters	.001
Cubic Centimeters	Cubic Meters	1000000
Cubic Meters.....(m³)	Cubic Feet.....	.028317
Cubic Meters	Cubic Centimeters	.000001
Cubic Inches.....(cu. in.)	Cubic Millimeters.....	.000061024
Cubic Inches	Cubic Centimeters	.061024
Cubic Inches	Cubic Meters	61023.74
Cubic Inches	Cubic Feet	1728
Cubic Feet.....(cu. ft.)	Cubic Meters.....	35.31467
Cubic Feet	Cubic Inches	.0005787
(CAPACITIES)		
Cubic Centimeters.....(cc)or(cm³)	Fluid Ounces.....	29.57373
Cubic Centimeters	Liquid Pints	473.17647
Cubic Centimeters	Liquid Quarts	946.35295
Cubic Centimeters	Liters	1000.028
Cubic Inches.....(cu. in.)	Liters.....	61.02545
Cubic Feet.....(cu. ft.)	Liters.....	.035316
Cubic Feet	Gallons	.13368
Fluid Ounces.....(fl. oz.)	Cubic Centimeters.....	.033814
Liquid Pints.....(liq. pt.)	Cubic Centimeters.....	.0021134
Liquid Quarts.....(liq. qt.)	Liters.....	1.056718
quid Quarts	Gallons	4
Liters.....(l)	Liquid Quarts.....	.94633
Liters	Gallons	3.78531
Liters	Cubic Inches	.016387
Liters	Cubic Feet	28.31605
Gallons.....(gal.)	Liquid Quarts.....	.25
Gallons	Liters	.26418
Gallons	Cubic Feet	7.48052
(WEIGHTS)		
Grams.....(g)	Ounces, avdp.....	28.34952
Grams	Grains	.064799
Kilograms.....(kg)	Ounces, avdp.....	.02835
Kilograms	Pounds, avdp.	.45359
Grains.....(gr.)	Grams.....	15.43236
Ounces, avdp.....(oz. avdp.)	Grams.....	.035274
Ounces, avdp.	Pounds, avdp.	16
Pounds, avdp.....(lb. avdp.)	Kilograms.....	2.20462
Pounds, avdp.	Ounces, avdp.	.0625
(PRESSURES)		
Kilogram-Meters.....(kg-m)	Foot-Pounds.....	.13826
Foot-Pounds.....(ft-lb)	Kilogram-Meters.....	7.23301
Foot-Pounds	Inch-Pounds	.083333
Inch-Pounds.....(in-lb)	Foot-Pounds.....	12
lograms Per Square Centimeter.....(kg/cm²)	Pounds Per Square Inch.....	.070307
Pounds Per Square Inch.....(lb/in²)	Kilograms Per Square Centimeter.....	14.22334

LEFT

TO OBTAIN:	MULTIPLY:	BY:

(DENSITIES)

rams Per Cubic Centimeter(g/cc)	Pounds Per Cubic Inch....	27.67991
Grams Per Cubic Centimeter	Kilograms Per Cubic Meter	.001
Kilograms Per Cubic Meter.(kg/m^3)	Pounds Per Cubic Foot....	16.018463
Pounds Per Cubic Inch.....(lb/in^3)	Grams Per Cubic Centimeter.	.036127
Pounds Per Cubic Inch	Pounds Per Cubic Foot	.0005787
Pounds Per Cubic Foot.....(lb/ft^3)	Grams Per Cu. Centimeter.	62.42796
Pounds Per Cubic Foot	Kilograms Per Cubic Meter	.062428
Pounds Per Cubic Foot	Pounds Per Cubic Inch	1728

(MISCELLANEOUS)

Slope Degrees.....	Grade Percentage.....	.9
Grade Percentage.....	Slope Degrees.....	1.11111
Degrees Fahrenheit.....(°F)	Degrees Centigrade.....	1.8 & add 32
Degrees Centigrade.....(°C)	Degrees Fahrenheit.....	*
Metric Horsepower.....(ps)	U.S. Horsepower.....	1.01387
U.S. Horsepower.....(hp)	Metric Horsepower.....	.98632
Kilometers Per Liter.....(km/l)	Miles Per Gallon.....	.4252
Miles Per Gallon.....(mpg)	Kilometers Per Liter.....	2.352
Kilometers Per Hour.....(km/h)	Miles Per Hour.....	1.60934
Miles Per Hour.....(mph)	Kilometers Per Hour.....	.62137

*Degrees Centigrade = .55556(°F-32)

BRITISH (B.)-ENGLISH (U.S.)-METRIC CONVERSION TABLES

Miles.....(B.)	Miles.....(U.S.)	**
ards	Yards	**
Feet	Feet	**
Inches	Inches	**
Inches.....(B.)	Centimeters.....	**
Feet	Meters	**
Miles	Kilometers	**
Pounds.....(B.)	Kilograms.....	**
Gallons.....(B. Imp.)	Gallons.....(U.S.)	.83267
Quarts.....(B.)	Quarts	.83267
Pints	Pints	.83267
Ounces	Ounces	1.04084
Gallons.....(U.S.)	Gallons.....(B. Imp.)	1.20095
Quarts	Quarts.....(B.)	1.20095
Pints	Pints	1.20095
Ounces	Ounces	.96076
Gallons.....(B. Imp.)	Liters.....	.21998
Quarts.....(B.)	Liters	.8799
Pints	Liters	1.7598
Ounces	Liters	35.19609
Liters.....	Gallons.....(B. Imp.)	4.54596
Liters	Quarts.....(B.)	1.13649
Liters	Pints	.56825
Liters	Ounces	.028412

** SEE METRIC-ENGLISH TABLES: BRITISH and ENGLISH Lengths & Weights Are Equal.

NEED LBS PER CUBIC FT & INCH
NEED OUNCES PER CUBIC FT & INCH } TO GRAMS & KILOGRAMS & ALSO REVERSE

RIGHT.

25 25

COMPARISON OF WIRE & SHEET METAL GAGES

~~(Dimensions in Decimal Parts of an Inch)~~

EXPLAIN CODES, ACTS OF CONGRESS, GENERAL MODERN ACCEPTANCES & PRACTICES THIS PAGE

LEFT

(DIMENSIONS IN DECIMAL PARTS OF AN INCH)

24
26

GAGE No.	STUBS' STEEL WIRE GAGE (for drill rod)	STEEL WIRE GAGE (for iron & steel wire)	IMPERIAL or BRITISH STANDARD WIRE GAGE	UNITED STATES STANDARD GAGE (for iron & steel sheet & plate)	BROWN & SHARPE or AMERICAN WIRE GAGE (for metal sheet & wire other than iron or steel)	GAGE No.
7-0's =	--	.4900	.500	--	--	= 7-0's
6-0's =	--	.4615	.464	.4687	.5800	= 6-0's
00000 =	--	.4305	.432	.4375	.5165	= 00000
0000 =	--	.3938	.400	.4062	.4600	= 0000
000 =	--	.3625	.372	.3750	.4096	= 000
00 =	--	.3310	.348	.3437	.3648	= 00
0 =	--	.3065	.324	.3125	.3249	= 0
1 =	.227	.2830	.300	.2812	.2893	= 1
2 =	.219	.2625	.276	.2656	.2576	= 2
3 =	.212	.2437	.252	.2500	.2294	= 3
4 =	.207	.2253	.232	.2344	.2043	= 4
5 =	.204	.2070	.212	.2187	.1819	= 5
6 =	.201	.1920	.192	.2031	.1620	= 6
7 =	.199	.1770	.176	.1875	.1443	= 7
8 =	.197	.1620	.160	.1719	.1285	= 8
9 =	.194	.1483	.144	.1562	.1144	= 9
10 =	.191	.1350	.128	.1406	.1019	= 10
11 =	.188	.1205	.116	.1250	.0907	= 11
12 =	.185	.1055	.104	.1094	.0808	= 12
13 =	.182	.0915	.092	.0937	.0720	= 13
14 =	.180	.0800	.080	.0781	.0641	= 14
15 =	.178	.0720	.072	.0703	.0571	= 15
16 =	.175	.0625	.064	.0625	.0508	= 16
17 =	.172	.0540	.056	.05625	.0453	= 17
18 =	.168	.0475	.048	.05000	.0403	= 18
19 =	.164	.0410	.040	.04375	.0359	= 19
20 =	.161	.0348	.036	.03750	.0320	= 20
21 =	.157	.0317	.032	.03437	.0285	= 21
22 =	.155	.0286	.028	.03125	.0253	= 22
23 =	.153	.0258	.024	.02812	.0226	= 23
24 =	.151	.0230	.022	.02500	.0201	= 24
25 =	.148	.0204	.020	.02187	.0179	= 25
26 =	.146	.0181	.018	.01875	.0159	= 26
27 =	.143	.0173	.0164	.01718	.0142	= 27
28 =	.139	.0162	.0148	.01562	.0126	= 28
29 =	.134	.0150	.0136	.01406	.0113	= 29
30 =	.127	.0140	.0124	.01250	.0100	= 30
31 =	.120	.0132	.0116	.01093	.00893	= 31
32 =	.115	.0128	.0108	.01015	.00795	= 32
33 =	.112	.0118	.0100	.00937	.00708	= 33
34 =	.110	.0104	.0092	.00859	.00630	= 34
35 =	.108	.0095	.0084	.00781	.00561	= 35
36 =	.106	.0090	.0076	.00703	.00500	= 36
37 =	.103	.0085	.0068	.00664	.00445	= 37
38 =	.101	.0080	.0060	.00625	.00396	= 38
39 =	.099	.0075	.0052	--	.00353	= 39
40 =	.097	.0070	.0048	--	.00314	= 40

RIGHT

MELTING POINT & DENSITIES OF VARIOUS ELEMENTS, ALLOYS, & LIQUIDS

(Approximations)

ELEMENTS & ALLOYS	MELTING POINT °C	MELTING POINT °F	DENSITIES lb. per cu. ft.	DENSITIES lb. per cu. in.
Aluminum	660	1220	168.5	.097
Brass	950	1742	530	.306
Bronze	1050	1922	550	.318
Carbon	3550	6422	219.0	.126
Chromium	1890	3434	449.3	.259
Copper	1083	1981	556.6	.321
Gold	1063	1945	1204.3	.695
Iron	1535	2795	496.1	.286
Iron, cast	1200	2192	450	.260
Iron, wrought	1510	2750	480	.277
Lead	328	622	707.6	.408
Magnesium	651	1204	108.6	.063
Molybdenum	2610	4730	636.5	.367
Nickel	1453	2647	555.4	.320
Silver	961	1762	655.2	.378
Stainless Steel	1480	2696	484	.279
Steel	1430	2606	489	.282
Tin	232	450	454.6	.262
Titanium	1675	3047	280.8	.162
Tungsten	3410	6170	1207.4	.697
Vanadium	1890	3434	371.9	.215
Zinc	419	786	445.5	.257
LIQUIDS				
Acetone			49.4	6.6
Alcohol, ethyl			49.4	6.6
Alcohol, methyl			50.5	6.8
Benzene			56.1	7.5
Gasoline			42.0	5.6
Glycerin			78.6	10.5
Kerosene			51.2	6.9
Oil, castor			60.5	8.1
Oil, mineral			57.4	7.7
Oil, petroleum			51.2	6.9
Water			62.4	8.4

COLOR SCALE OF TEMPERATURES FOR MILD STEELS

(Approximations)

COLOR	TEMPERATURE °C	TEMPERATURE °F
Red heat, visible in dark	400	752
Red heat, visible in twilight	474	885
Red heat, visible in daylight	525	977
Red heat, visible in sunlight	581	1078
Dark red	700	1292
Dull cherry-red	800	1472
Cherry-red	900	1652
Bright cherry-red	1000	1832
Orange-red	1100	2012
Orange-yellow	1200	2192
Yellow-white	1300	2372
White welding heat	1400	2552
Brilliant white	1500	2732
Dazzling white (bluish-white)	1600	2912

MINUTES-TO-DEGREE DECIMALS
& SECONDS-TO-MINUTE DECIMALS

OR

EXAMPLES OF USAGE

MINUTES (SECONDS)		DEGREES (MINUTES)
1	=	.0167
2	=	.0333
3	=	.0500
4	=	.0667
5	=	.0833
6	=	.1000
7	=	.1167
8	=	.1333
9	=	.1500
10	=	.1667
20	=	.3333
30	=	.5000
40	=	.6667
50	=	.8333
60	=	1.0000

ANGLE EQUIVALENTS

DEGREES (°)	MINUTES (')	SECONDS (")
1	60	3600
.016667	1	60
.000278	.016667	1

RIGHT

STEVEN ENGINEERING
INCORPORATED

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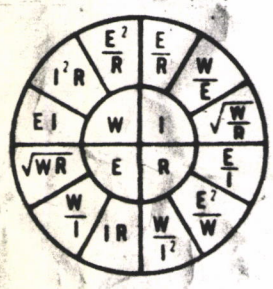
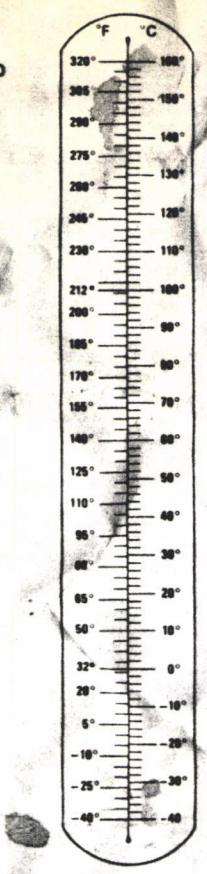
RENO, NV
(702) 329-3999

ANGLO – METRIC CONVERTER



OHM'S LAW

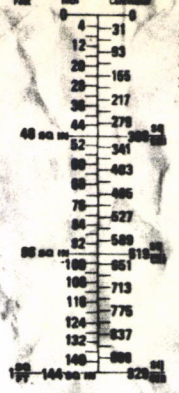
TEMPERATURE



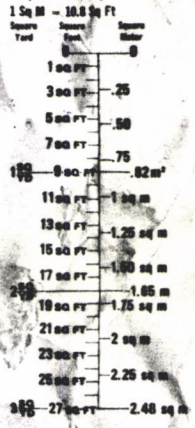
32° Fahrenheit = 0° Celsius
0° Fahrenheit = 17.8° Celsius

AREA

1 Sq Ft = 144 Sq In = 929.03 Sq Cm
1 Sq In = 6.4516 Sq Cm
1 Sq Cm = .155 Sq In



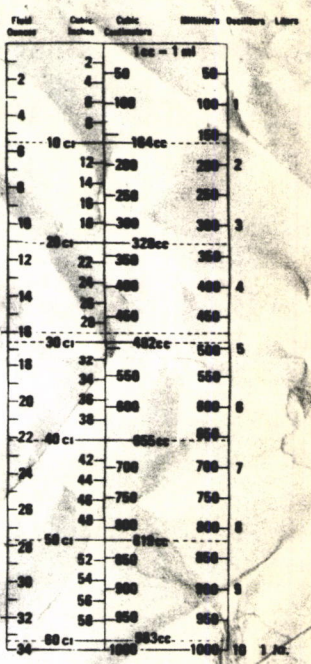
1 Sq Yd = 9 Sq Ft = .82 Sq M
1 Sq Ft = .093 Sq M
1 Sq M = 10.8 Sq Ft



CAPACITY

Unit	U.S. Fluid Ounce	U.S. Liquid Pint	U.S. Liquid Quart	Cubic Inch	Cubic Centimeter	Deciliter	Liter
1 U.S. FL OZ =	1	.0625	.03125	1.8047	29.574	.2957	.0296
1 U.S. LIQ PT =	16	1	.5	28.875	473.18	4.7316	.4732
1 U.S. LIQ QT =	32	2	1	57.75	946.35	9.4633	.9463
1 Cubic Inch =	0.5541	.03463	.01732	1	16.387	.1639	.0164
1 Cubic Centimeter =							
1 Milliliter =	0.0338	.00211	.00106	.06102	1	.01	.001
1 Deciliter =	3.3815	.2112	.1057	6.1025	100	1	.1
1 Liter =	33.815	2.1130	1.0567	61.025	1000	10	1

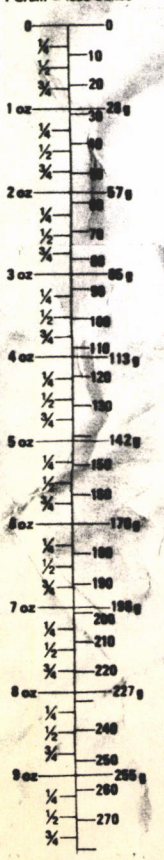
The Figures above alone have been rounded where full extension was impossible



WEIGHT

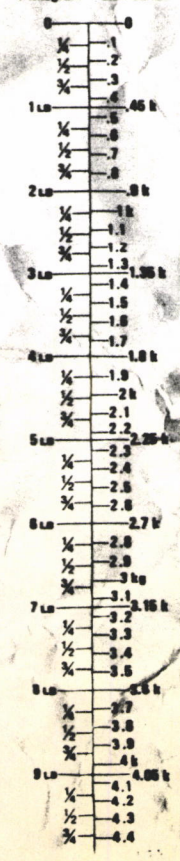
OUNCE GRAM

1 Ounce = 28 Gram
1 Gram = .035 Ounce



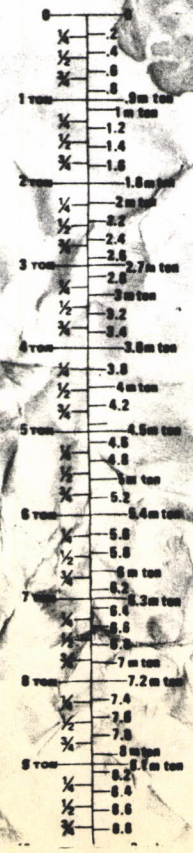
POUND KILOGRAM

1 Pound = .45 Kilogram
1 Kilogram = 2.2 Pound



SHORT TON METRIC TON
2,000 LB/2,200 LB

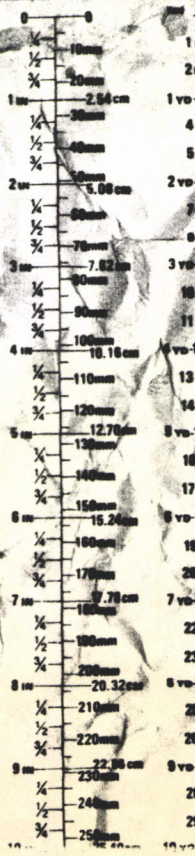
1 Ton = .907 Metric Ton
1 Metric Ton = 1.102 Ton



LENGTH

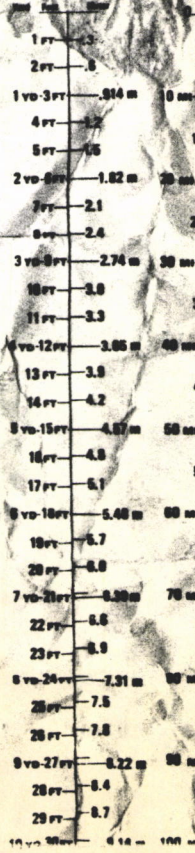
INCH MILLIMETER-CENTIMETER

1 Inch = 25.4 Millimeter
1 Inch = 2.54 Centimeter
1 Millimeter = .03937 Inch
1 Centimeter = .3937 Inch



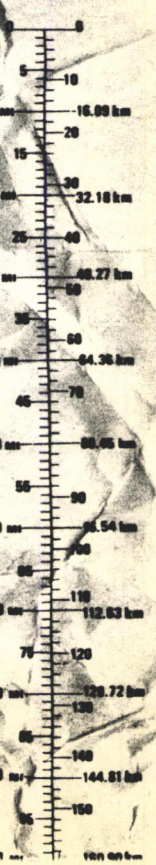
YARD-FEET METER

1 Yard = .914 Meter
1 Meter = 1.094 Yard
1 Foot = .3048 Meter
1 Meter = 3.2808 Feet



MILE KILOMETER

1 Mile = 1.609 Kilometer
1 Kilometer = .6214 Mile



SAE/METRIC

GENERAL TORQUE SPECIFICATIONS

(When SAE 10 oil is used as a lubricant)

Material	SAE 2 Mild Steel	SAE 5	SAE 8	Skt Head Cap Screw
Min Tensile Strength	74 000 PSI	120 000 PSI	150 000 PSI	160 000 PSI
Steel Grade Symbols				
Bolt Dia.	Torque – Foot Pounds			
1/4"	6	10	14	16
5/16"	12	19	29	33
3/8"	20	33	47	54
7/16"	32	54	78	84
1/2"	47	78	119	125
9/16"	69	114		
5/8"	96	150		
3/4"	150			

Torque Table (Coarse threds)

Dia (mm)	Pitch (mm)	kg-m	ft-lbs
5	0.90	0.35 ~ 0.50	2.5 ~ 3.5
6	1.00	0.60 ~ 0.90	4.6 ~ 6.5
8	1.25	1.6 ~ 2.2	11.5 ~ 16.0
10	1.50	3.1 ~ 4.2	22 ~ 30
12	1.75	5.4 ~ 7.5	39 ~ 54
14	2.00	8.3 ~ 11.5	60 ~ 83
16	2.00	13 ~ 18	94 ~ 130
18	2.50	18 ~ 25	130 ~ 181
20	2.50	26 ~ 35	188 ~ 253

Conv

END OF BOOK ?

5/29/84

DO I WANT TO INCLUDE:

PROB PP. 116 (L) 117 (R) A COUPLE PAGES OF CRANKSHAFT NOTES

NO — IGNITION TIMING CURVE FORMULAS (IS ON PRINTOUT — MORE PRINTOUTS WILL BE ORDERED IF FORMULAS NOT PRESENT)

PROB PP. — 112 (L) 113 (R) 114 (L) 115 (R) PISTON CLACE K-FACTOR CHART & DISCUSSIONS ? → (WRITTEN FOR 2-STROKES — 4-STROKERS CAN PICK OUT WHAT'S REVEGANT OR APPLICABLE)

PROB — COMPRESSION RATIO FORMULAS, CHART, & DISCUSSIONS ? 107 (R) PP. 106 (L) (2 SECTIONS — 1 FOR 2 STROKES, 1 FOR 4 STROKES) 108 (L) & 109 (R) 110 (L) & 111 (R)

PROB — MEP, BMEP, HP, TORQUE, BHP, PoLAN, ME, IHP, VE FORMULAS & DISCUSSIONS? (AT END OF BOOK)

PP. 118 (L) 119 (R) 120 (L) 121 (R)

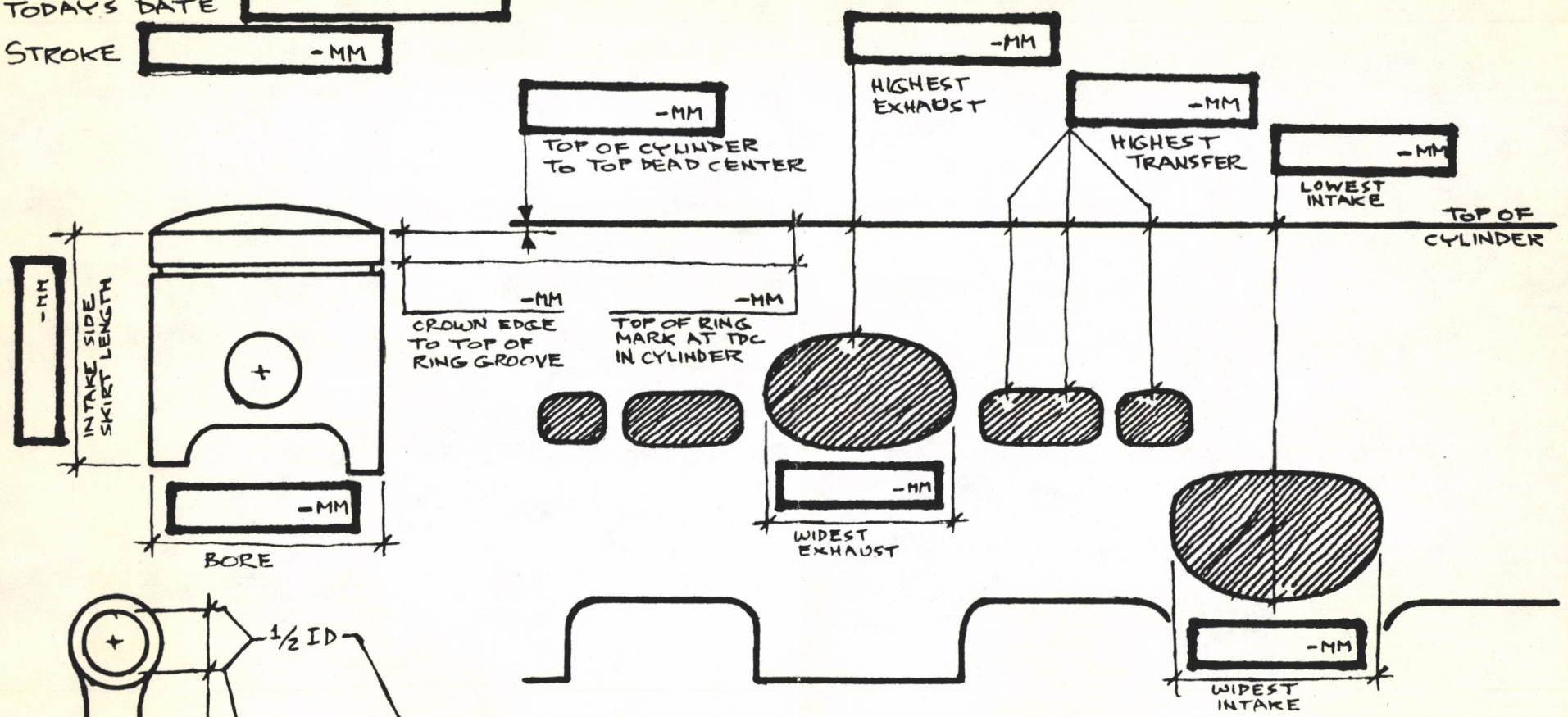
12 QUESTIONS FOR "2STROKE" PROGRAM - PILOT SOFTWARE - 1/1/84 - JEFF BRATTON

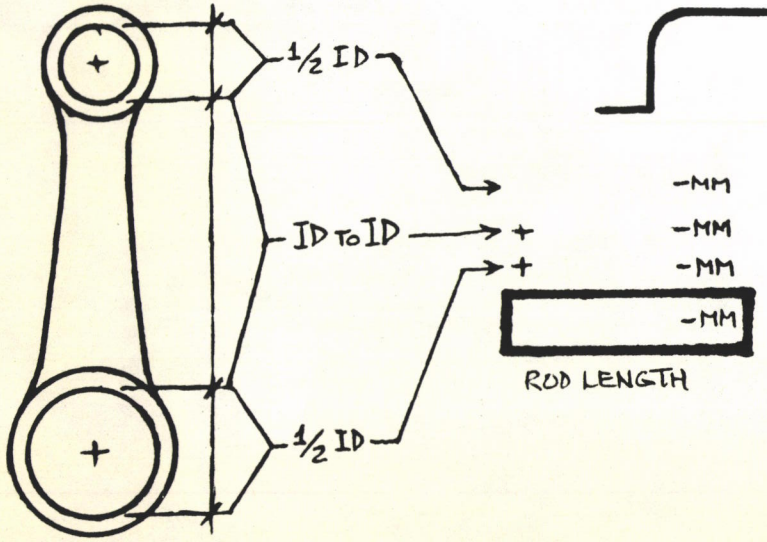
YEAR/MANUFACTURER/MODEL

TODAY'S DATE

STROKE -MM

ANSWER TO CLOSEST 100TH -MILLIMETER





SPECIAL NOTES (HAND ENTRY):

- STOCK OR MODIFIED ?
- BRIDGED EXHAUST &/OR INTAKE ?
- REVERSE ROTATING CRANK ?
- ETC.

WORKSHEET FOR PISTON-PORT INTAKE

5/29/84

p 123 BLANK (RIGHT)

p 124 ~~[illegible]~~ LEFT

p 125 RIGHT

p 126 LEFT

p. 127 RIGHT

} INDEX

p. 128
129
130
131
132

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END